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APPENDIX A. PRIOR REPORTS AND RELATED MANAGEMENT PLANS

Existing studies of the restoration of Hetch Hetchy Valley are clustered in two distinct groupings: 1) work performed by the state and federal governments between 1988 and 1990, focusing on the 1987 proposal of former Secretary of the Interior Donald Hodel to study restoring Hetch Hetchy; and 2) more recent analyses, conducted between 2002 and 2005, including proposals from Environmental Defense and Restore Hetch Hetchy and two related master theses from the University of California.¹ The Resources Agency has reviewed each of these works in the context of existing and relevant resource management plans produced by federal, state, and local agencies. These resource management plans, such as the California Water Plan Update 2005 and the California Outdoor Recreation Plan, provide perspective in evaluating the collection of existing work on Hetch Hetchy.

The Hodel Study Proposal

In July 1987, Secretary of the Interior Donald Hodel proposed to study the removal of O'Shaughnessy Dam and the restoration of Hetch Hetchy Valley. In response, between early 1988 and early 1990, the federal and state governments issued a total of five reports about Hodel's proposal. All five were based upon existing information (i.e., no new studies were performed at that time). Three of the five reports focused on potential alternatives for replacing lost water and power supplies and their costs, while two focused mostly on different options for the restored valley. Only one of the five reports discussed the potential environmental impacts of removing O'Shaughnessy Dam and replacing lost water and power supplies. None of the reports focused on the potential benefits of restoration of or recreation in Hetch Hetchy Valley, nor attempted to quantify those benefits economically. Only one of the reports was supportive of the restoration study concept. The five reports from that era are summarized below.

Hetch Hetchy: A Survey of Water and Power Replacement Concepts **U.S. Bureau of Reclamation, Mid-Pacific Region** **February 1988**

During the summer of 1987, Secretary Hodel directed the U.S. Bureau of Reclamation (Reclamation) to prepare a reconnaissance-level review of his Hetch Hetchy restoration study proposal, on behalf of the National Park Service. In its February 1988 report (*Hetch Hetchy: A Survey of Water and Power Replacement Concepts*), Reclamation optimistically identified several options for replacing the water and power supplies lost by the removal of O'Shaughnessy Dam. For example, in the preface to the report, Reclamation promoted the restoration proposal, stating that the concept could “intrigue the mind and free the imagination”—notwithstanding the water and power impacts it could create.

Reclamation identified 11 concepts for replacing the water and power provided by Hetch Hetchy Reservoir. The first three focused on re-operation or modification of existing facilities on the Tuolumne River (including Don Pedro Reservoir.) Options 4 through 10 focused on providing any make-up water the first three did not produce. Option 11 described possible replacements for any net loss of power supply not replaced by water supply options. Noting that some bundling of options would probably be necessary, the report lists as the three most promising alternatives (to

¹ These reports are available at the Resources Agency web site dedicated to the Hetch Hetchy Study: www.hetchhetchy.water.ca.gov.

replace water not provided by re-operation of the upper Tuolumne system): 1) a conjunctive use program in the American, Tuolumne, and Stanislaus basins; 2) Los Vaqueros Reservoir (at 1 million acre-feet); and 3) coordinated operations of Reclamation's Solano Project (i.e., Lake Berryessa) with the North Bay Aqueduct of the State Water Project. Reclamation also discussed options such as raising Shasta Dam, enlarging local San Francisco Public Utilities Commission (SFPUC) reservoirs, and interconnecting Bay Area water utilities. Based on dry-year hydrology, Reclamation estimated that over 100,000 acre-feet (af) of water could still be diverted annually from the Tuolumne River without O'Shaughnessy Dam. Reclamation also estimated an additional 250,000 af could be developed from re-operation of Lakes Cherry and Eleanor, thereby *increasing*—not decreasing—diversions from the upper Tuolumne River to the SFPUC service area. Reclamation also projected power loss costs to be \$51 million annually in 1987, growing to \$109 million in 2000.² Reclamation concluded by recommending and describing a six-year feasibility-level study, estimated at the time to cost \$3-5 million.^{3,4}

Alternatives for Restoration of Hetch Hetchy Valley Following Removal of the Dam and the Reservoir **National Park Service** **1988**

As a companion piece to the Reclamation study, the National Park Service (NPS) produced *Alternatives for Restoration of Hetch Hetchy Valley Following Removal of the Dam and the Reservoir* in 1988. In it, NPS outlines three scenarios for how restoration might be accomplished:

1. Recovery without direct management, in which the reservoir is drawn down in one year;
2. Recovery with moderate management, with the reservoir drawn down over five years (and with the five years preceding drawdown dedicated to collecting native plants, seeds, and propagules); and
3. Recovery with intensive management, also with a five-year drawdown.

For each alternative, NPS illustrated the potential vegetation and wildlife responses at various time stages up to 150 years. While NPS offered no preference for any of the three options, it did predict that for the latter two alternatives, after 150 years, the “entire valley would appear much as it did before construction” of O'Shaughnessy Dam.

NPS also described a monitoring plan for each alternative to help evaluate the restoration's effectiveness. In its study assumptions, NPS concluded that sediment removal would be unnecessary, the Tuolumne River would return to its original channel on its own, growth of non-native vegetation would be tolerated to some extent, and widespread herbicide usage would not be employed. The report also mentioned the need for “mechanical obliteration of the scars left by dam construction,” including removing the material excavated from the dam site that was deposited in the lower meadow, filling a gravel pit near Wapama Falls, and filling a sand pit near the confluence of Rancheria Creek with the Tuolumne River. Beyond simply replanting native species, NPS suggests the use of active management tools in alternatives two and three, such as watering, protective fencing, avian enclosures, greenhouse and nursery services, horticultural techniques, predator removals, fire suppression and prescribed burning, and suppression or elimination of “noxious” non-native plants.

² The 1987 costs assumed energy at \$0.0223 per kilowatt-hour, and \$0.0847 per kilowatt-hour in 2000.

³ Of note, the Reclamation report provides an appendix of comments received on it—both pro and con—which are instructive reading in and of themselves.

⁴ A Congressional subcommittee later prohibited funding for the feasibility study.

Hetch Hetchy: Striking a Balance **U.S. Department of Energy** **January 1988**

In response to a draft version of Reclamation's report, the U.S. Department of Energy (DOE) published its own study, *Hetch Hetchy: Striking a Balance*, in January 1988.⁵ At best, the report gives Hodel's idea a lukewarm reception, finding that while the restoration concept had "some merit," restoring Hetch Hetchy simply was not viable at that time. DOE asserted that restoration is one of those "noble ideas that seem like the right thing to do" at first but, after a "reasoned analysis," is "less attractive than the initial reaction might suggest."

In its report, DOE focused on costs, not benefits, and found that the removal of O'Shaughnessy Dam would result in a "significant" loss of water and power (specifically, a loss of 300,000 af of storage, 900 million kilowatt-hours of energy, and 150 megawatts of dependable capacity). In addition, DOE noted that replacement options would have significant water quality and other environmental impacts, involve difficult legal issues (including water rights), and negatively impact whitewater recreation. DOE also commented that the Reclamation alternatives would require more pumping compared to the status quo, making replacement options "net energy consumers, and thereby aggravating the overall power loss" situation. In terms of dollars, DOE estimated that lost power from the removal of O'Shaughnessy Dam would have an initial annual cost of \$80 million, rising to a levelized average of \$109 million—not including the potential additional energy required by replacement alternatives—compared with costs (at that time) of \$39 to \$59 million (capital and O&M) of Hetch Hetchy hydropower.⁶

DOE concluded that the cost of restoring Hetch Hetchy Valley was too high for the intangible benefits provided, without quantifying many of those costs and any of the benefits of the proposal. Further, DOE stated that for the "average person" the resource values of a restored valley were not "substantially higher than those that presently exist" (i.e., as a reservoir), but did not discuss what those values were. DOE did recommend that the restoration concept be revisited towards the end of O'Shaughnessy Dam's useful life (i.e., after 2023, based upon DOE's estimate at that time). The report reasons that at such time, replacement water and power resources may already be in some stage of development; therefore, the environmental and economic costs of these options would be less. Moreover, decommissioning of the dam would be "necessary, instead of optional"; thus, dam removal costs would not be "assessed" against the economic benefits of restoring Hetch Hetchy Valley in a cost-benefit analysis. DOE suggested that dam removal would cost "several hundred million dollars" but did not detail or support those costs. Interestingly, DOE pondered whether O'Shaughnessy Dam is eligible for the National Register of Historic Places, raised the possibility of leaving the dam in place (but draining the reservoir), and stated that the current reservoir constitutes a "water-based visual and recreational resource" that adds "diversity to scenic and recreational opportunities" of Yosemite National Park.

Restoring Hetch Hetchy **California State Assembly Office of Research** **June 1988**

In June 1988, the California State Assembly's Office of Research (AOR) focused primarily on restoration alternatives for Hetch Hetchy Valley in *Restoring Hetch Hetchy*, which concluded that

⁵ At the time, DOE was led by Californian John Herrington. Interestingly, prior to serving as Secretary of the Interior, Donald Hodel preceded Herrington as Secretary of Energy in the administration of President Ronald Reagan.

⁶ The initial \$80 million figure is composed of \$34 million annually in lost energy (assuming oil at \$20/barrel) and \$46 million annually in lost capacity. Power replacement costs assumed construction of a new thermal facility with a 30-year life.

Hetch Hetchy was more valuable as a reservoir than as a restored valley. In what is largely a visual document, AOR takes a political and historical perspective⁷ on Hetch Hetchy, commenting that both John Muir and San Francisco were right in 1913, but that Congress decided San Francisco was “more right” given the tradeoffs involved. Through historical photos and diagrams, the report provided different views and perspectives of the scenic qualities of Hetch Hetchy Valley, including a detailed comparison of Hetch Hetchy with Yosemite Valley. If restored, AOR predicted that Hetch Hetchy Valley would have a “somewhat natural appearance” in 10 years if planted with nursery trees, “much longer” if “Nature does all the planting.” AOR also observed that the restored valley might be available for recreation within as little as two years. AOR forecasted 400,000 visitor-days per year by 2000 to a restored valley without recreational facilities and 1 million per year if restored and developed like today’s Yosemite Valley. AOR also suggested opening the existing reservoir to more recreation.

AOR also briefly discussed water and power replacement options, noting that, in general, the alternatives “aren’t wonderful.” Nonetheless, AOR did offer a preferred scenario, which was to: 1) build a 200-foot-high dam downstream of Hetch Hetchy at Early Intake Dam⁸ (though calling the dam site “poor to miserable”), which would inundate Poopenaut Valley with 50,000 af of water; 2) re-operate Lakes Eleanor and Cherry to provide water instead of power; and 3) divert water from Don Pedro or buy it from agriculture. Such an alternative—which AOR described as the best, though most expensive—would replace all of the water and 70% of the power, the remainder of which would be purchased on the market. AOR believed that the water supply would be the easiest to replace—with water quality dependent upon that choice—and power the hardest, with the lowest environmental and economic costs if the solution focused on re-operating existing reservoirs on the Tuolumne system. At the time, AOR estimated the loss of removing O’Shaughnessy Dam, for both water and power, at nearly \$60 million annually, or a one-time cost of \$825 million.⁹ AOR did recognize—but did not quantify—recreational benefits of a restored valley, but it did not consider its non-use, or “existence,” value. In a parting shot, AOR commented that if \$825 million was indeed available to restore Hetch Hetchy, it could be better spent on making improvements in Yosemite Valley, specifically, by limiting cars in the valley.

AB 645 Report **Department of Water Resources, State of California** **January 1990**

In January 1990, the California Department of Water Resources (DWR) briefly summarized the restoration studies to date in a report to the legislature pursuant to AB 645. DWR found that O’Shaughnessy Dam should not be removed, given the value of its benefits, including “pollution-free” water and power. DWR closed its report with two rather obvious findings: 1) removing O’Shaughnessy Dam would eliminate 360,000 af of storage from the Hetch Hetchy system; and 2) 75 megawatts (MW) of electrical generating capacity would be lost at Kirkwood Powerhouse. DWR specifically comments on the “irony” of Hodel’s proposal for those in the California water community, in that, San Franciscans have historically disparaged other water projects while “ignoring their own city’s environmental transgressions.”

⁷ AOR nonetheless makes a significant historical error in the identification of the San Francisco City Attorney who later became Secretary of the Interior at an opportune time during the Woodrow Wilson administration.

⁸ Early Intake Dam was built in 1924 to divert water from Cherry Creek or the Tuolumne River into Mountain Tunnel. In addition to the diversion dam, Early Intake is also the location of SFPUC’s Kirkwood Powerhouse and a work compound.

⁹ AOR assumed \$200 per acre-foot for an annual loss of 114,000 acre-feet of water, and \$0.04 per kilowatt-hour for an annual loss of 885 million kilowatt-hours of energy.

Recently Published Works

Summarized below are four recent works—two major reports from environmental organizations and two related master’s theses at the University of California—that have rekindled public interest in the restoration of Hetch Hetchy Valley. It is noteworthy that, compared with the Hodel proposal, none of these four recent works were issued by government agencies, and that all four view the restoration concept favorably. The release of these reports coincided with the publication of a series of Pulitzer-prize winning editorials by Tom Philp in the *Sacramento Bee*. Also included is a summary of information provided to DWR by the SFPUC in response to Environmental Defense’s report.

Reassembling Hetch Hetchy: Water Supply Implications of Removing O’Shaughnessy Dam

**Sarah E. Null, Department of Geography, University of California, Davis
December 2003**

As her master’s thesis in the Geography Department at UC Davis, Sarah Null wrote *Reassembling Hetch Hetchy*. In it, Null takes an academic approach to the question of whether the SFPUC could live without Hetch Hetchy Reservoir, focusing on an intertie to Don Pedro Reservoir supplemented by dry-year purchases from the agricultural sector as a replacement. To conduct her study, Null utilized an engineering-economic optimization model of California’s water systems called “CALVIN” (California Value Integrated Network), which uses 72 years of historical hydrology (1922-93 monthly, unimpaired, historical flow data). CALVIN is a simplified model of California’s water and river systems (including groundwater and major hydropower plants), with an objective of minimizing economic costs, but unconstrained by legal and institutional realities. For this study, CALVIN was run using projected urban and agricultural demands in 2020 and 2100.

Null found that removing O’Shaughnessy Dam, combined with a Don Pedro intertie, would not necessarily increase water scarcity or have effects outside the Tuolumne River basin. She also predicted that Hetch Hetchy storage would be far less valuable in the future, when SFPUC would divert and deliver (rather than store) Tuolumne flows at O’Shaughnessy Dam. Null projected annual power revenue losses of \$12 million in 2020 and \$9.5 million in 2100.¹⁰ If the Hetch Hetchy supply loses its filtration avoidance status, the thesis estimated water treatment capital costs of \$2 billion, with annual O&M costs of \$13 million. Interestingly, Null also found that the Don Pedro intertie and additional capacity in the Hetch Hetchy system was valuable, even if O’Shaughnessy Dam remained in place. She further speculated that there was “little value” in expanding Don Pedro or local SFPUC reservoirs, but some value to expanding the Cherry/Eleanor complex (specifically for hydropower). Null did not consider economic benefits from recreation, tourism, or other development associated with a restored valley. She concluded that losing filtration avoidance status for Hetch Hetchy could be the “driving factor” in any restoration proposal.

The Potential Economic Benefits of Restoring Hetch Hetchy Valley

**Jessica K. Rider, Goldman School of Public Policy, University of California at Berkeley
May 2004**

As a graduate student at the Goldman School of Public Policy at UC Berkeley, Jessica Rider wrote *The Potential Economic Benefits of Restoring Hetch Hetchy Valley* to provide guidance to Environmental

¹⁰ The thesis assumed “monthly varying wholesale electricity prices” for these hydropower revenue loss estimates.

Defense on strategies to frame the debate on restoring Hetch Hetchy Valley. In her report, Rider characterizes the use and non-use benefits resulting from removing O'Shaughnessy Dam and restoring Hetch Hetchy Valley.

Rider derived use benefits results from projected visitation to a restored Hetch Hetchy Valley, depending upon the level of development. These use benefits range from about \$200 million per year for the low end of the low development scenario to about \$1.4 billion at the high end of the high development scenario. Rider cautions that the benefits in the high development scenario are very likely overstated. She also notes that the difficulty and uncertainty of predicting visitation clouds the validity of the use value estimates.

Rider attempts to characterize the non-use benefits by considering the non-use value associated with Mono Lake, as well as recent National Park Service expenditures for land acquisition as an indication of value. Ultimately, she concludes that to better determine non-use values, a study directly focusing on Hetch Hetchy Valley must be performed. The report does not consider the costs of dam demolition or valley restoration.

Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley **Environmental Defense** **September 2004**

Environmental Defense (ED) issued *Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley* in September 2004. In it, ED asserts that without O'Shaughnessy Dam, the Tuolumne River could still provide most of the water SFPUC needs (via a "run-of-the-river" diversion in the vicinity of O'Shaughnessy Dam or Early Intake Dam), with the balance coming from releases from Cherry and Eleanor Reservoirs that are captured downstream via an intertie at Don Pedro Reservoir. While Hetch Hetchy storage provides a relatively small amount of supply to SFPUC in normal and above normal years, ED does concede that it is important in dry and critical years. ED predicts that, together, the run-of-the-river diversion and Don Pedro intertie would meet SFPUC demands in four out of five years, and, in particular, winter and spring demand could be met by an upper Tuolumne diversion alone. ED also asserts that only during critically dry years would new supplies be required to meet about 20% of SFPUC's delivery objectives.

Paradise Regained is supported by three consultant reports in the fields of water management, water quality, and water law.¹¹ To conduct its study, ED developed and used its own computer simulation model, TREWSSIM (Tuolumne River Equivalent Water Supply Simulation Model), to analyze the operations of SFPUC, Modesto Irrigation District (MID), and Turlock Irrigation District (TID), using both current and projected 2030 demand. Assumptions in the model include: the completion of the SFPUC's Water System Improvement Program, including construction of a fourth San Joaquin Pipeline (raising conveyance capacity to 542 cubic feet per second (cfs), the hydraulic capacity of the Coast Range Tunnel); expansion of Calaveras Reservoir to 420,000 af; and expansion of the Sunol Valley Filter Plant to 240 millions of gallons per day (mgd). In addition, each replacement alternative in the report also included a further expansion of the Sunol plant to 400 mgd. ED focuses primarily upon an intertie between Don Pedro Reservoir and the Hetch Hetchy water system, which could capture flows released from Lakes Cherry and Eleanor. Other alternatives explored included an intertie with the State Water Project via expansion of the South Bay Aqueduct, groundwater exchange (both in the San Francisco Bay Area, as well as along the lower Tuolumne and San Joaquin Rivers), and water transfers during dry years. ED does not suggest that SFPUC conserve, recycle, or desalinate to replace water now provided by

¹¹ *Paradise Regained* also opens with a foreword co-signed by two former Resources Agency secretaries, Douglas Wheeler and Huey Johnson.

O'Shaughnessy Dam. Nonetheless, ED did observe in passing that two existing regional projects—the Bay Area Blending/Exchange Project (for drinking water) and the Bay Area Regional Water Recycling Project (for wastewater reuse)—could be part of a Hetch Hetchy solution. *Paradise Regained* includes an extended discussion (in an appendix) of water quality issues.

Across the entire Hetch Hetchy system, ED predicted that hydropower would fall by 20-40% with the removal of O'Shaughnessy Dam. While it focuses solely on supply-side options for water replacement, ED emphasizes demand-side solutions to replace energy supplies lost, such as increased efficiency and dynamic pricing, as well as purchasing and generating new supplies, especially from renewable sources that do not further degrade air pollution. *Paradise Regained* also suggests that Kirkwood Powerhouse could still be fed, at times, from Hetch Hetchy if appropriate modifications were made to the Canyon Power Tunnel.

Altogether, ED estimates replacement of water and power supplies due to the removal of O'Shaughnessy Dam to cost from \$500 million to \$1.65 billion¹². This estimate does not include the costs of dam removal, new recreational facilities, or restoration of Hetch Hetchy Valley, nor does it consider any economic benefits of increased recreation and tourism. ED largely avoids discussion of the environmental impacts of dam removal or the development of replacement water and power supplies.

Finding the Way Back to Hetch Hetchy Valley **Restore Hetch Hetchy** **September 2005**

In November 2005, Restore Hetch Hetchy (RHH), a nonprofit advocacy organization, released, *Finding the Way Back to Hetch Hetchy Valley*, in which it contends that water and power resources lost due to removal of O'Shaughnessy Dam could be replaced, in most years, by a combination of infrastructure and conservation projects.¹³ These projects include a new diversion structure downstream of the dam to directly divert the Tuolumne River into the SFPUC's water system, a pumped diversion from Cherry Creek (downstream of Holm Powerhouse) to the Mountain Power Tunnel, enlarging Don Pedro Reservoir, and implementing a comprehensive water efficiency program. RHH relies on a combination of analysis from the ED and UC Davis reports to analyze and compare these alternatives, as well as water conservation analysis from the Pacific Institute. As such, the conclusions reached by RHH are not markedly different than those reached by ED and Null, though they do contain some additional analysis. Namely, instead of merely utilizing existing storage in Don Pedro, RHH proposed raising the level of Don Pedro from 10 to 26 feet, raising or re-operating Cherry Dam, and desalination and conjunctive use in the SFPUC service area.

A second focus of the RHH report is the removal of O'Shaughnessy Dam and remediation of Hetch Hetchy Valley. RHH estimates dam removal would take 5 years and would cost \$100 million dollars. In conjunction with dam removal, RHH analyzed a passive and an active approach to valley remediation, both to begin immediately after removal of the dam structure. RHH estimated that active restoration of the valley would cost approximately \$20 million and take up to 10 years; no estimate was given for passive restoration.

¹² The total ED cost range represents a net present value, over 50 years, of both capital and operation and maintenance (O&M) costs, using a discount rate of 5%. In particular, ED estimated energy replacement costs at between \$19-38 million annually, assuming \$55 per megawatt-hour.

¹³ The RHH report opens with a letter from former Interior Secretary Donald Hodel.

Response to Paradise Regained

San Francisco Public Utilities Commission

2005

SFPUC provided four “technical reports” to DWR for use in preparing this *Hetch Hetchy Restoration Report*. These reports are essentially a rebuttal of the ED report.

- **Water Quality and Environmental Impacts**

The first technical report submitted by SFPUC, prepared by Camp, Dresser & McKee (CDM), is *Water Quality Review of Environmental Defense’s Paradise Regained: Solutions for Restoring Yosemite’s Hetch Hetchy Valley*. In this report, CDM states that the changes suggested by the ED report would lead to increased energy requirements due to pumping and replacement of hydropower as opposed to the way the current system operates under complete gravity flow. CDM states that there will be impacts associated with the production, use, and disposal of treatment chemicals and their residuals. CDM emphasized the high quality of water from Hetch Hetchy Reservoir and how it requires minimal chemical addition. The report also describes construction impacts for the new system components.

- **Reduced Power Generation and Increased Energy Consumption**

The second technical report submitted by SFPUC, prepared by Robert F. Logan, is *Review of Environmental Defense’s Estimates of the Cost to Replace Lost Hydropower*. It states that ED did not consider the costs of replacing lost hydropower with energy efficiency, dynamic pricing and renewable energy. It questions the replacement of lost hydropower with natural gas fired power. It questions the ED estimates of the average annual energy needed to pump and filter water and the lack of discussion of the loss of peaking capacity.

- **Central Valley Flood Risk**

The third technical report submitted by the SFPUC, prepared by MBK Engineers, is entitled *Assessment of the Flood Control Impacts of the Removal of Hetch Hetchy Dam and Reservoir, Tuolumne River, California*. In this report, MBK Engineers states that the flood operation of New Don Pedro Reservoir could be significantly impacted by the removal of Hetch Hetchy Reservoir storage from the Tuolumne River watershed.

- **Legal Precedents and Institutional Barriers**

The fourth technical report submitted by SFPUC, prepared by Ellison, Schneider & Harris, is *Response to Legal Issues Raised by Environmental Defense Proposal*. This report covers complex legal and institutional issues pertaining to the SFPUC Capital Improvement Program (CIP), the Raker Act, the distribution of water rights on the Tuolumne River, and the agreements between Modesto and Turlock irrigation districts.

Related Management Plans

California Water Plan Update 2005

The *California Water Plan* is the state’s strategic plan for water resources management. The 2005 update to the plan provides a “Framework for Action” to ensure a sustainable and reliable water supply in 2030, and to focus and prioritize state government’s water planning, oversight, and technical and financial assistance. DWR predicts that future water management challenges will be more complex as population increases, demand patterns shift, environmental needs are expressed, and global climate change materializes. To respond to these challenges, policy makers and the

public will need more detailed information about costs, benefits, and tradeoffs associated with different water management strategies.

The specific goals of the *California Water Plan Update 2005* include:

- State government supports good water planning and management through leadership, oversight, and public funding.
- Regional efforts play a central role in California water planning and management.
- Water planning and urban development protect, preserve, and enhance environmental and agricultural resources.
- Natural resource and land use planners make informed water management decisions.
- Water decisions are equitable across all communities.

Further, to ensure that our water supply is sustainable, California water management must be based on three foundational actions:

- Use water efficiently
- Protect water quality
- Manage water in ways that protect and restore the environment

To ensure that our water supplies are reliable, water management must pursue two initiatives that incorporate these actions:

- Promote and practice integrated regional water management
- Maintain and improve statewide water management systems

While the *California Water Plan Update 2005* acknowledges the current study of Hetch Hetchy Valley restoration, the plan does not make a recommendation on the concept or even its further study.

California's Power Supply Outlook

In 2003, the California Energy Commission (CEC) adopted its first *Integrated Energy Policy Report* (IEPR), which provided an assessment of major energy trends and issues facing California, along with recommended energy policies. The recommendations were based on extensive technical assessments captured in three volumes on 1) electricity and natural gas; 2) transportation fuels, technologies, and infrastructure; and 3) public interest energy strategies. The 2004 update to the IEPR focused on three areas:

- reliability issues with aging power plants
- transmission planning
- accelerated renewable energy development

A new IEPR (IEPR-05) was adopted by the CEC on November 21, 2005, which assessed the progress California has made on the 2003 recommendations.

According to IEPR-05, California faces significant challenges in coming years with ensuring adequate electricity supplies to keep California's lights on during critical peak demand periods. To address this problem, California must step up its efforts to achieve the goals already established for demand response programs, make better use of its existing fleet of power plants, and move aggressively to bring new resources on-line.

Also in 2003, an *Energy Action Plan* was adopted by the California Energy Commission, the California Public Utilities Commission, and the California Power Authority. The plan establishes

shared goals and specific actions to ensure that adequate, reliable, and reasonably-priced electrical power and natural gas supplies are achieved and provided through policies, strategies, and actions that are cost-effective and environmentally sound for California's consumers and taxpayers.

California must also act now to ensure that its long-term energy strategy, the plan's "loading order", is realized. California's principal energy agencies have been meeting regularly to coordinate activities, programs, and proceedings in critical energy areas, and have made progress implementing the loading order strategy.

Near-term Concerns. Analysis undertaken for the IEPR-05 indicates that as many as 9,000 MW of aging power plants are considered to be at risk for retirement by 2008. While it is doubtful that all of these aging power plants will retire (because retiring a portion of them would likely improve the financial prospects for those remaining on-line), additional steps must be taken to ensure that California has adequate supplies over the next few years. Depending upon how many of these aging power plants retire between now and 2008, reserve margins in the state could become dangerously thin, primarily in Southern California. Owners of aging power plants may choose to retire these units because the units are unable to fully recover their costs during the relatively few hours of the year that they operate. Keeping this capacity available over the next few years will prove a challenge, while California transitions away from reliance on electricity generated under DWR's contracts to electricity generated by newly constructed plants.

Long-term Concerns. California must not lose sight of its long-term goals for planning transmission and developing renewable energy supplies.

Transmission upgrades and expansions are critical to ensuring a robust, reliable, and economic electricity system. To meet stated policy goals, California's transmission planning process must address the need for transmission to access future merchant generation and renewable resources.

California must develop and codify ambitious long-term renewable goals to continue the flow of investments in renewable resources in the state. Significant progress has been made on the accelerated goal of meeting 20 percent of California's retail electricity sales with renewables by 2010. However, the state must set long-term targets for renewables for 2020 to maintain momentum.

Hetch Hetchy "Connection". The Hetch Hetchy system provides clean, low-marginal-cost energy to California's electrical system. The issue of reducing generation capacity in the short-term is probably not a problem, since it is unlikely any significant changes could be implemented before 2008. In the long-term, Hetch Hetchy generation is not large when considered in a statewide system setting. Nevertheless, Hetch Hetchy generation is a major source of power for San Francisco's municipal uses and for TID and MID. Replacement of any generation losses to these three parties is a primary concern with huge cost implications for their constituents.

In the future, management of California's energy supply will also be difficult as population and overall demand increases, existing generation and transmission facilities age, investment in new generation and transmission facilities stalls due to lack of long-term contracts, generation from renewable resources increases, and the price for natural gas (the most common fuel for generation) continues to increase.

The IEPR-05 proposes California address its increasing needs in the following manner:

- Reduce energy demand through efficiency and alternative resources by
 - ♦ Continuing to be a leader in efficient use of electricity

- ♦ Emphasizing peak demand reduction, not just energy savings
- ♦ Decreasing the energy use of the water sector
- ♦ Increasing advanced metering and demand response programs
- ♦ Streamlining and expediting the Renewable Portfolio Standard process
- Improve the energy infrastructure by
 - ♦ Improving the transmission planning and permitting process
 - ♦ Continuing expansion of natural gas infrastructure within the state
 - ♦ Encouraging the construction of new infrastructure to deliver liquefied natural gas to the state
- Reduce potential impacts from climate change by
 - ♦ Reducing California's contribution to greenhouse gas emissions
 - ♦ Supporting the Climate Action Registry for trading emission reductions
 - ♦ Supporting the Climate change Advisory Committee to evaluate statewide level strategies to deal with climate change

California Outdoor Recreation Plan

The California Outdoor Recreation Plan (CORP) is required under Public Resources Code Section 5099 - 5099.12 and is a federal requirement for California to maintain its eligibility to receive federal funds from the Land and Water Conservation Fund.

California's state-level outdoor recreation planning program is the continuation of nearly 50 years of effort by California State Parks. The plan is typically revised every five years to reflect current and expected changes in California's large and complex population and economy. The current CORP was produced in 2002.

The CORP provides a tool for statewide outdoor recreation leadership and action for the next five years. The objectives of the plan are to determine the recreation issues that are currently the most critical problems and opportunities in California and to explore the most appropriate actions by which service providers at all levels of federal, state, local, private and nonprofit might best address them. The plan comprehensively addresses the full range of recreation issues throughout the entire state. The plan also considers important trends in outdoor recreation and subjects of topical interest.

Water 2025 (U.S. Department of the Interior)

Water 2025 is a U.S. Department of the Interior initiative to manage scarce water resources and develop partnerships to nourish a healthy environment and sustain a vibrant economy. Water 2025 encourages voluntary water banks and other market-based measures, improves technology for water conservation and efficiency, and removes institutional barriers to increase cooperation and collaboration among federal, state, tribal, and private organizations.

Under this program, four California projects received grants in 2004 ranging from \$200,000 to \$300,000 for improvements to water systems to reduce seepage losses. These projects are: Calleguas Municipal Water District in Thousand Oaks, Contra Costa Water District in Concord, Imperial Irrigation District in El Centro and Stevenson Water District in Merced.

In 2005, almost \$10 million worth of Challenge Grants were awarded by Water 2025. They will help to fund 43 projects in 13 states. In total, more than \$27 million worth of improvements in water infrastructure will be made, counting matching local and private funds.

Yosemite National Park Management Planning Documents

In 1980, the NPS adopted the *Yosemite National Park General Management Plan* (General Management Plan). The plan established five broad goals to guide the management of Yosemite National Park and to perpetuate its natural splendor:

- Reclaim priceless natural beauty
- Allow natural processes to prevail
- Promote visitor understanding and enjoyment
- Markedly reduce traffic congestion
- Reduce crowding

The General Management Plan included several goals and actions that specifically address Hetch Hetchy. The following goals were identified:

Public Use Goals

- Continue use as a destination for visitors who wish to view the dam, the reservoir and the valley
- Continue to provide backcountry access from Hetch Hetchy

Public Use Actions

- Retain parking for dam and trailhead
- Retain picnic area
- Provide connecting trail from stock unloading area

Park Operations Goals

- Provide an adequate supply of treated water for domestic use
- Provide waste treatment that meets state and federal standards

Park Operations Actions

- Develop additional surface water sources for domestic water

The General Management Plan recognized that new analyses would be necessary to determine how best to accomplish these goals. Since 1980, additional studies and analyses have been conducted (along with additional planning and public involvement), particularly related to natural processes, transportation, and housing. Information from these analyses has been used in the most recent comprehensive planning effort for Yosemite Valley, culminating in the *Final Yosemite Valley Plan/Supplemental EIS* (2000). Because information from these additional analyses was incorporated into this recent planning effort, the *Final Yosemite Valley Plan/Supplemental EIS* amends the 1980 General Management Plan by modifying some specific provisions while implementing many other provisions of the General Management Plan.

Specific purposes of the *Final Yosemite Valley Plan/SEIS* within Yosemite Valley are to:

- Restore, protect, and enhance the resources of Yosemite Valley
- Provide opportunities for high-quality, resource-based visitor experiences
- Reduce traffic congestion
- Provide effective park operations, including employee housing, to meet the mission of the National Park Service

The scope of the 1980 General Management Plan encompassed all of Yosemite National Park, including Hetch Hetchy and Lake Eleanor. The more recent Yosemite Valley Plan provides more specific detail in carrying out the goals and actions that relate to Yosemite Valley. If Hetch Hetchy Valley were to be restored, a specific management plan focused on Hetch Hetchy Valley would need to be developed. Many of the issues discussed and alternatives analyzed for Yosemite Valley could be used as a model for addressing similar issues that might face Hetch Hetchy Valley when planning for future restoration activities and recreation opportunities.

Yosemite National Park Resources Management Plan

The *Resources Management Plan for Yosemite National Park* was updated in 1994. It presents an inventory and description of natural and cultural resources; describes and evaluates the current resources management program; and prescribes an action program based on legislative mandates, National Park Service policies, and provisions of related planning documents. (NPS 2000)

Tuolumne Wild and Scenic River Comprehensive Management Plan

The Tuolumne River was designated as a Wild and Scenic River in 1984 by Congress under the authority of the 1968 Wild and Scenic Rivers Act. This requires the managing agencies to prepare a comprehensive management plan (CMP) for the river and its immediate environment. Although the 8 miles within Hetch Hetchy Reservoir are excluded, the river above the dam and nearly 7 miles below the dam, totaling 54 miles within the park's borders, is covered by this designation.

NPS plans to concurrently develop a management plan and a related implementation-level plan (Tuolumne Meadow Development Concept Plan.) Planning process elements will include identifying and determining boundaries, classifications, Outstandingly Remarkable Values, the Wild and Scenic River Act Section 7 process, the River Protection Overlay, management zoning, and the Visitor Experience and Resource Protection (VERP) framework. The VERP framework is a tool developed by NPS to address user capacities. It is an ongoing, iterative process of determining desired conditions, selecting and monitoring indicators and standards that reflect these desired conditions, and taking management action when the desired conditions are not realized.

Once the management guidelines from the CMP are in place, planning will begin on determining the best use of land in Tuolumne Meadows. An Environmental Impact Statement will be prepared to analyze alternatives and their impacts for each plan. Data collection and gathering of background information began in the summer of 2005 and public scoping will commence in late spring 2006. Completion (resulting in a Record of Decision) is currently targeted for spring 2008.

Tuolumne County General Plan

The *Tuolumne County General Plan*, last updated in 1996, does not include any recommendations for land use, development or recreation at Hetch Hetchy, as the reservoir is wholly on federal lands

within a national park. Additionally, there are no references to other parts of the Tuolumne River or its corridor outside of NPS boundaries in the general plan either.

SFPUC Water Supply Master Plan

The *Water Supply Master Plan* was developed cooperatively between the SFPUC and the Bay Area Water Users Association (now Bay Area Water Supply and Conservation Agency, or BAWSCA) to address the future water supply needs of San Francisco, its retail customers outside the city, and its wholesale customers in San Mateo, Santa Clara and Alameda counties. The plan focused on examining options to meet growing demand on the system through 2030 in terms of reliability, cost, water quality, operational flexibility, and environmental impacts.

SFPUC Water System Improvement Plan

The San Francisco Public Utilities Commission (SFPUC) has embarked on a multi-billion dollar multi-year program to rebuild the Hetch Hetchy water system. The Water System Improvement Program (WSIP), vital to the future public health and safety of the San Francisco Bay Area, will deliver capital improvements that enhance the SFPUC's ability to provide reliable, affordable, high quality water to its 2.4 million customers in an environmentally sustainable manner. The WSIP is the largest capital program currently being undertaken by any water agency in the West.

The WSIP is structured to cost-effectively provide water quality, seismic reliability, delivery reliability and water supply improvements for the future. The SFPUC worked with outside experts, regional partners and numerous stakeholders to create and refine the WSIP. Experts—whose focus is major capital programs, cost-estimating, environmental review, and the design and construction of dams, tunnels, pipelines, and treatment facilities—were consulted to provide thorough reviews of scope, schedules and budgets. Industry standard costing practices, which are recommended by the American Association of Cost Engineers, and the experience of large capital programs recently undertaken by utilities, such as Southern Nevada Water Agency and Orange County Sanitation District, were reviewed to develop the most accurate cost estimates for the WSIP. Finally, stakeholders concerned about river habitat, watershed lands, growth in urban areas and the health and safety of Bay Area residents were consulted to create a WSIP that has wide support.

Reference

National Park Service (NPS). 2000. Final Yosemite Valley Plan: Supplemental Environmental Impact Statement (EIS). Yosemite National Park, CA.

APPENDIX B. LEGAL ISSUES

The legal issues raised by restoring Hetch Hetchy Valley must necessarily be considered in a general way. The legal issues can only be fully and accurately evaluated once a specific proposal is made on how the restoration is to be accomplished, and will obviously turn in great part on what facilities are selected and what institutional arrangements are proposed. Virtually all the alternatives for water and power supply replacement involve the use of controversial water transfers in the Tuolumne River system, Don Pedro Reservoir, the lower San Joaquin River basin, and the Sacramento-San Joaquin Delta. Legal issues include: 1) water rights of the city and county of San Francisco, and Modesto and Turlock irrigation districts; 2) the federal Raker and Power acts, as well as the federal and state Wild and Scenic River acts; and 3) the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). In addition, beyond statutory and regulatory issues, applicable case law and, perhaps most significantly, the public trust doctrine, may affect some replacement alternatives.

Policy Consensus

The issues will also turn on the nature of the political and policy consensus moving the proposal and on who the participants are. For example, if San Francisco were to decide to join or lead the restoration effort, then the Raker Act, which bestows rights on the city, may not raise many issues—perhaps only questions regarding the rights, duties, and liabilities of the voluntary relinquishment or abandonment of the city's rights of way and physical facilities. If, on the other hand, San Francisco were to oppose the effort, then the Raker Act would likely raise significant issues, such as the need for Congress to amend the act and deal with questions involving eminent domain law and condemnation rights, powers, and liabilities.

The discussion of legal issues presented here presupposes that a state and national policy consensus will be arrived at that will include state and federal legislation, addressing not only issues of policy and funding but also of the authority of various state and federal entities needed to undertake or participate in the project. Thus, the question of authority to take particular actions will not be discussed here. Also, this discussion does not assume the changing of any regulatory statutes.

Environmental Review

CEQA and NEPA compliance spans all the potential activities and approvals involved in a restoration plan. A variety of approaches may be taken, including a master environmental assessment or a programmatic or tiered approach, which addresses the impacts of the project as a whole.

Reasonable Use and Public Trust

Another set of issues that attend all questions of water use are the general state law requirements of Article 10, Section 2, that water be used reasonably and beneficially and the public trust doctrine. Because this discussion assumes a legislative ratification and because the legislature is empowered to take action under both authorities, these issues need not be discussed here. There may be application of these doctrines in specific areas of a proposed plan that would need to be examined in the context of that plan.

Dam and Reservoir Removal

This topic concerns the physical act of removing O'Shaughnessy Dam. It is understood that dam removal, while possible, is not a necessity for valley restoration; it may be that only the cessation of reservoir storage and dam operation is necessary for restoration.

- **Authority:** As noted, any necessary authority to remove the dam is or will be a function of state or federal enabling legislation.
- **Water quality impacts:** The activities involved in all aspects of construction or demolition activity in a waterway raise issues of water quality degradation and regulatory requirements, such as those under Section 404 and other sections of the Clean Water Act (CWA), state water quality requirements (Porter-Cologne Water Quality Control Act) for waste discharges, and state implementation of the federal CWA. There would also be water quality considerations in connection with any sediment removal at the dam site.
- **Environmental documentation and protection:** NEPA (for federal actions) and CEQA (for state actions) will be the chief mechanisms for environmental documentation. Given the materials usually present in dams, compliance with laws governing hazardous materials handling and disposal will likely be involved. Finally, state and federal Endangered Species Act (CESA and ESA), Wild and Scenic Rivers Act, and Fish and Game Code Section 1600 are among the other major environmental statutes that are likely to be involved in a dam removal project.
- **Safety issues:** While this subject overlaps with hazardous materials handling issues, the chief issue is compliance with state law regarding the safety of dams. Removal must be conducted in manner that will not impose a risk of failure while dam removal is in progress.

Consequences of Dam Removal

- **Flow alteration:** Cessation of upstream storage, with or without removal of the dam, will alter the flow regimen between Hetch Hetchy and Don Pedro reservoirs.
 1. *Flooding and flood control:* The chief issue is what, if any, added risk to and liability for downstream flooding is raised by the cessation of storage in Hetch Hetchy? How does dam removal affect the flood control operation at Don Pedro or the downstream protections it provides?
 2. *Instream impacts:* A reservoir that has existed for decades will be replaced by a free-flowing stream. This alteration has potential regulatory implications under Fish and Game Code Section 1601 (streambed alteration), for impact on protected species (ESA and CESA), and for the environment in general, to which NEPA and CEQA requirements will apply. (Again, NEPA and CEQA compliance will likely require consideration of the whole restoration project.) The scope and impact of existing Wild and Scenic Rivers Act and Wilderness Act designations will be raised.
 3. *Water quality impacts:* The substitution of a free-flowing stream for a reservoir may have its own water quality issues, as distinguished from those impacts directly associated with the removal of the dam. These may include issues of sediment transport, scouring, erosion, and resuspension of accumulated sediments at the dam site and upstream of it, which will require compliance with the CWA and Porter-Cologne.
 4. *Department of Interior management:* The lands that Hetch Hetchy inundates are managed by the National Park Service of the Department of Interior. Restoration will both affect and be affected by their management duties and powers.

- **Recreational impacts:** These impacts, centering on the loss of lake-related recreation in favor of meadow and stream-related recreation, will be under the legal purview of the National Park Service. The assessment of these impacts falls under CEQA and NEPA.
- **Water rights and supply impacts:** With the loss of operation of the Hetch Hetchy Reservoir, water rights and water supply impacts are main issues in any restoration scenario. San Francisco holds pre-1914 water rights under the Civil Code to appropriate water from the Tuolumne River. The Modesto and Turlock Irrigation Districts hold pre-1914 appropriative rights on the Tuolumne River that are earlier in time and therefore senior to San Francisco's. There are also other appropriative and riparian water users on the system.
- **San Francisco water rights:** The primary legal question here is to define the scope of San Francisco's water rights, including priority, diversion, and storage rights, as well as the rights to future expansion of use. This will be germane both to the value of San Francisco's rights and to requirements for a substitute water supply.
- **MID, TID, and other right holders:** The scope of San Francisco's water rights must be defined, at least in part, in relation to other rights on the system, principally those of MID and TID. The exercise of MID's and TID's rights will be affected by the altered regimen of flows that will occur in the absence of storage at Hetch Hetchy.
- **Organizational and contractual obligations:** San Francisco, MID and TID have entered into four agreements over the past 72 years that concern water rights to the Tuolumne, operation of Hetch Hetchy, flood control, cost-sharing for New Don Pedro, storage and a water banking and credit-exchange agreement for New Don Pedro, and sharing of FERC operational requirements at New Don Pedro¹⁴. The rights and duties under these agreements would have to be resolved by the parties if Hetch Hetchy is no longer operational.
- **Water quality impacts:** In addition to the water quality issues raised above, removal of the dam would have two sets of impacts cognizable under state and federal law:
 1. *Source water quality at New Don Pedro Reservoir:* This will particularly affect municipal and industrial (M&I) uses if San Francisco is to take its substitute water supply from that reservoir via a new Don Pedro intertie or in the Delta, if that is to serve as a source for San Francisco's substitute supply.
 2. *Drinking water quality:* Treatment and compliance with federal EPA and state DHS requirements for San Francisco will come into play with either of the new water sources.
- **Federal statutes:** Various other federal laws (other than the Raker Act) are implicated in dam removal:
 1. *Wilderness Act:* The area surrounding, but not including, the reservoir is a designated Wilderness Area under the federal Wilderness Act, which mandates the preservation of wilderness values of included lands. Presumably, this designation will need to be re-examined if the reservoir is drained.
 2. *Wild and Scenic Rivers Act:* In similar fashion, the reservoir is excepted from the designation of the Tuolumne River under the federal Wild and Scenic Rivers Act and will likewise need to be re-examined.

¹⁴ Of note, O'Shaughnessy Dam is not subject to FERC.

Water Supply Replacement

A. Storage proposals

- **Use of new Don Pedro storage:** Under whatever scenario by which San Francisco, MID, and TID may come to share the storage benefits of New Don Pedro Reservoir, a cost-sharing and operations agreement will have to be worked out by the parties.
- **Other storage options (e.g., Calaveras Reservoir enlargement):** These options will all raise the same basic legal issues involved in any water facilities construction project. Besides issues relating to construction, right of way, safety, operations, etc., the options would all have significant environmental and regulatory issues, depending on whether the proposals were for on-stream or off-stream storage.
- **Terminal storage operational issues:** If existing terminal storage, which is substantially regulatory storage, is converted into conservation storage for long-term water supply, then the re-operation of the reservoir can raise issues regarding both the downstream effects of changing release amounts and patterns, as well as the impact of a more dynamic operation on reservoir uses, such as lake recreation and fishing.

B. Water purchase/transfers

As an alternative or supplement to storage options to make up water supplies lost to San Francisco, water transfers raise issues regarding the protection of legal users of water and environmental impacts. The transfer of both surface water and groundwater may come under the area-of-origin restrictions of Water Code Sections 1215 et seq., which apply to water exports not subject to the watershed protection statutes applicable under the state's Central Valley Project Act.

- **Surface water:** Transfers involve changing some combination of the place of use, purpose of use, or point of diversion of an existing right. Under water rights law, junior appropriators of water are protected against the harmful impacts of such changes under the “no legal injury rule.”

In addition, changes in surface water use necessitated by transfers can raise issues of environmental impact on the aquatic and riparian environment, which trigger the operation of regulatory statutes such as the ESA and those found under Section 1700 et seq. of the Water Code.

- **Groundwater:** The legal issues posed in particular by groundwater transfers include potential restrictions on out-of-basin transfers under local groundwater ordinances.

C. Water rights

Legal issues are raised by any proposed change under existing water rights in connection with alternative water supply scenarios for San Francisco. If San Francisco changes the point of diversion for its water rights to New Don Pedro Reservoir or the Delta (or any other place), it may only do so if there will be no harm to existing legal users of water, whether or not those users are senior or junior in right to San Francisco.

Similar issues are raised if water rights for New Don Pedro storage are expanded to M&I purposes.

D. Conveyance Proposals:

- **Intertie between New Don Pedro and Hetch Hetchy Aqueduct:** This proposal is for an intertie to be constructed between New Don Pedro Reservoir and San Francisco's Hetch Hetchy Aqueduct. This proposal has the same sort of general legal issues as any

construction project, as well as the need for an agreement with TID and MID. This raises no particular conveyance issues.

- **Delta diversion:** One proposal involves San Francisco's water to be released or passed through New Don Pedro down the Tuolumne, the San Joaquin, and into the Delta for diversion on San Francisco's behalf by either the SWP or the CVP. This proposal raises issues regarding the legal ability of San Francisco to use capacity in the SWP and CVP systems under Water Code Section 1810 et seq., under which owners of conveyance systems must, upon the satisfaction of certain conditions, allow others to use their conveyance facilities. Issues have also been raised as to priority of use.
- **Hetch Hetchy Aqueduct/California Aqueduct Intertie:** Another aspect of the previous conveyance scenario involves interconnection of the Hetch Hetchy Aqueduct and the California Aqueduct, and would take the San Francisco water diverted from the Delta from the SWP system and put it into San Francisco's system. This proposal raises issues similar to the New Don Pedro Intertie proposal, requiring an agreement with DWR on construction and operation issues.

Power Replacement

- **New Don Pedro (FERC and power issues):** Currently, there exists a FERC license for the generation of electricity at New Don Pedro. This license would have to be modified to account for changes in storage and operations if San Francisco stores water at that facility. This also implies that a new agreement would need to be negotiated between San Francisco and TID and MID on FERC compliance obligations and costs.
- **New or other generation options:** One of the major impacts of not storing water at Hetch Hetchy is the loss of generating capacity. If that capacity is to be replaced, then new sources of energy must be found, whether through contract with existing suppliers or through the construction of new energy production facilities.

Site Restoration

The legal issues involved in restoration—including authority, cultural preservation, environmental documentation and protection, and Native American resources management issues—will be determined by the particular restoration goals and objectives that are chosen.

Raker Act

The Raker Act confers rights and duties upon the City and County of San Francisco with respect to the use of the National Park, the supply of water with regard to other downstream users, and the generation and provision of hydroelectric power.

The scope of San Francisco's rights conferred under the Raker Act must be determined, as well as its state water rights. One question about its duties is whether, under the act or by contract, San Francisco has incurred responsibilities that would survive a relinquishment of its Raker Act rights.

MID and TID rights are the other side of the same question. Do the districts have statutory or contractual rights that would survive San Francisco's relinquishment of its Raker Act rights to use Hetch Hetchy Valley for reservoir and water supply purposes?

APPENDIX C. PUBLIC USE IN THE VALLEY

The California Department of Parks and Recreation (DPR) assessed the potential public use opportunities associated with Hetch Hetchy Valley. As a unit of California State Government, DPR is not involved in the management of Yosemite National Park. DPR also assessed the economic implications of alternate uses of the Valley. To preserve the range of possibilities for any future change in policy, DPR explored different types of recreation experiences that might be possible in the valley—even if those experiences may currently be prohibited by either statute or policy. In examining alternatives to the status quo, DPR encountered two fundamental choices: whether to allow body contact in the existing reservoir and whether to drain the reservoir. With those choices in mind, DPR analyzed recreation trends in California, reviewed existing reports on the Hetch Hetchy Valley, and considered comments on the possible spectrum of recreation opportunities (including “bookend” options from minimal development to a high degree of development). This information is only intended to illustrate possible ranges of recreation development. No decisions have been made, and extensive further study is needed by the Department of the Interior and others prior to making any conclusions regarding recreation in the area. It is understood that involvement of the Native American community with these lands is unique and the needs and issues involving Native Americans will be considered independent of those of the general public.

Size and Perspective

The resemblance of Hetch Hetchy Valley to Yosemite Valley was noted numerous times by 19th and early 20th century writers. Remarking on this similarity, John Muir wrote, “Nature is not so poor as to possess only one of anything¹⁵.” T. P. Maden, a member of the California Yosemite Board, described the valley in 1879 as follows: “It is much smaller than the Yosemite, and therefore, many of its objects are grouped together very grandly and very beautifully, and at once entrance the beholder; but Hetch Hetchy lacks many of the imposing features of the Yosemite. Still, if there had been no Yosemite, Hetch Hetchy would command the admiration of all who visit it, and would probably rank as the grandest and most beautiful aggregation of rock and water in the world—in fact, it would be Yosemite”¹⁶.

To place the size of Hetch Hetchy Valley into perspective, Yosemite Valley and Hetch Hetchy Valley are roughly the same length at approximately 7 miles long. According to National Park Service (NPS) staff, the primary difference is width. The average width of Yosemite Valley is approximately 1 mile, while the average width of Hetch Hetchy Valley is just over 0.5 mile.

Aesthetics

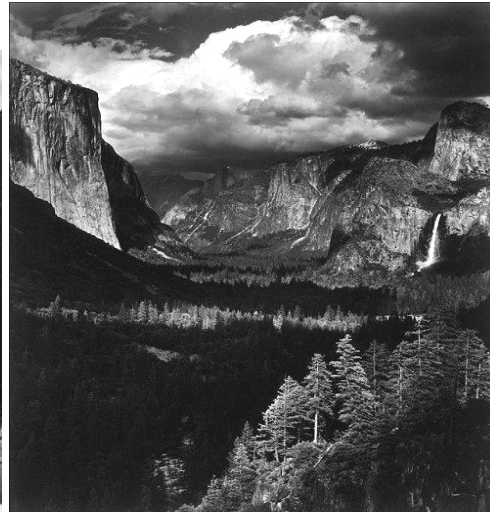
According to previous publications on the restoration of Hetch Hetchy Valley, the primary justification for removing the dam and restoring the valley is to reclaim a promised, beautiful landscape owned by the American people and that is currently submerged beneath water.

¹⁵ Huber, N. K. (2004). “A Tale of Two Valleys.” *Yosemite* 66(4), 6-9.

¹⁶ California Assembly Office of Research. (1988). *Restoring Hetch Hetchy*. (Publication No.0220-A). Sacramento, CA: Joint Publications Office.



The Hetch Hetchy Valley Before Dam Construction
Photographer: Unknown



The Yosemite Valley
Photographer: Ansel Adams

While beauty is a subjective concept, perhaps the most aesthetically striking characteristics of a restored Hetch Hetchy Valley would be the monolithic size of the valley's sheer granite cliffs (the summit of Kolana rock, which, according to John Muir¹⁷ ranks comparably in size to the Cathedral Rock in Yosemite Valley, towers 2,270 feet from the valley floor); the expansiveness of the open space from one side of the valley to the other; and the valley's waterfalls, which cascade down from impressive heights (Tueeulala Falls descends 1,000 feet and Wapama Falls descends 1,700 feet). It should be noted that the valley's granite cliffs, and all the height of the waterfalls, exist above the high-water mark of the reservoir.

Recreation Demand Trends in California

The demand for additional recreation opportunities in Hetch Hetchy Valley is potentially significant. Although Yosemite National Park is an area of national and global significance¹⁸, the trends discussed below reflect solely the demand of Californians for additional recreation opportunities within the state. Public opinion polling regarding unmet recreation demand within the state, paired with population projections for the next 50 years, suggests that the future demand for additional recreation opportunities by Californians is substantial. Further study is needed to substantiate the specific public demands for recreation use in Hetch Hetchy.

A 2002 survey of Californian's opinions and attitudes regarding outdoor recreation¹⁹ revealed that Californians' participation and demand for outdoor recreation is considerable²⁰.

The survey revealed that more than 9 out of every 10 Californians walk for fitness or fun, drive for pleasure, sightsee, or drive through natural scenery. The survey further suggests that at least half of Californians participated in the following additional activities: visit historic/cultural sites, attend outdoor cultural events, participate in beach activities, picnic, view wildlife, hike trails, swim, camp

¹⁷ Muir, J. (1912). Hetch Hetchy Valley. In *The Yosemite*. New York: The Century Co.

¹⁸ Yosemite National Park is part of the United States National Park System, and was designated a World Heritage Site by the United Nations in 1984.

¹⁹ California Department of Parks and Recreation. (2003). *Public Opinions and Attitudes on Outdoor Recreation in California: 2002*. California: Author.

²⁰ This survey was based on a random telephone sample of 2,512 adult Californians and was administered in both English and Spanish. This telephone sample is considered representative of all Californians within a margin of error of $\pm 2.1\%$. Each respondent was interviewed for an average of 12 minutes, and 610 of these participants responded to additional questions posed in a mailed questionnaire.

(at developed sites), and bicycle (on paved surfaces.) Respondents who indicated that they walk for fitness and fun did so, on average, 94 days per year. Respondents who participated in viewing wildlife, bird watching, and viewing natural scenery averaged 25 days per year.

Latent Recreation Demand

Of significance to this evaluation of the Hetch Hetchy Valley are the survey results for latent demand for recreation (participation in recreation activities that would take place if additional opportunities were available). The survey showed that Californians desire more opportunities for camping in developed sites and trail hiking than are currently available in the state. All forms of camping are in strong demand throughout California. Topping the list of activities in the state that possess a latent demand was camping in developed campgrounds that have facilities such as toilets and picnic tables. Nearly 50% of Californians who participated in the survey indicated that they camped at developed sites for nearly six days in 2002. Even camping at primitive sites (without any facilities) and backpack camping were popular with 28% and 20%, respectively, of respondents saying that they participated in these types of camping approximately two to three days a year. Californian's demand for facilities-intensive camping activities, such as those involving the use of a trailer or RV, was also strong. Nearly 20% of Californians participate in this activity approximately three times a year.

Outdoor recreation activities in the form of trail hiking and walking were also high on the latent demand list. Trail hiking was listed as the second most popular recreation activity in the state possessing a latent demand. This activity had a strong following, with nearly 69% of those surveyed indicating that they participated in this activity for approximately 17 days during 2002. Additionally, 91% of Californians indicated that they participated in recreational walking activities during 2002. These strong demand figures suggest that the public would welcome additional trails and better access to existing trails.

Other top 10 latent-demand outdoor recreation activities with applicability to Hetch Hetchy Valley (whether the reservoir is retained or not) include wildlife viewing (such as bird watching), picnicking, visiting outdoor nature displays, and visiting historical sites.

Surging Population

Concurrent with the above described unmet demand, California's population is increasing dramatically. In the year 2000, California's population was approximately 34 million. According to the California Department of Finance, by 2050, California's population will be approximately 55 million. If this estimate holds true, this growth represents a 62% increase in the state's population over the next 50 years. It could be a fair extrapolation from this data to assert that the demand for additional recreational opportunities will increase as a result of population growth.

Recreation Potential

There is a huge range of recreation possibilities that could be considered when attempting to assess the recreation potential of Hetch Hetchy Valley. Legal constraints and federal administrative guidelines and management plans notwithstanding, additional outdoor recreation opportunities at Hetch Hetchy may be sought out by Californians who visit Yosemite National Park, as well as by park visitors from across the country and around the world, if they were available. Further research is needed to verify this. In this section, we assess the current state of recreation in the valley, and detail potential alternatives to the status quo. As stated above, these alternatives require extensive additional evaluation if they are to be considered further.

Current Visitors to the Valley

According to Yosemite National Park staff, there are currently three general types of visitors²¹ to the Hetch Hetchy Valley:

1. short-stay day users (those who see the dam and stay 10-20 minutes),
2. long-stay day users (those who stay for several hours and take day hikes to the waterfalls in the area), and
3. backpackers (those who camp in the wilderness of Yosemite National Park and use trailheads in the Hetch Hetchy Valley).

Current Recreation Constraints

Recreation within Hetch Hetchy Valley is currently constrained by several factors. Primary among these are poor vehicular access, legal constraints, limited facilities, and limited staff.

Access

The valley is reachable by a long, narrow road restricted to vehicles less than 25 feet long and, because of security concerns, is closed to traffic at night. Due to the steep cross slope of the parking area near the dam site, there are no designated “accessible²²” parking spaces in Hetch Hetchy Valley, per se. An accessible pedestrian route crosses the dam from the parking area to and through the granite tunnel on the opposite side of the dam. This tunnel, the floor of which is rocky and uneven, in turn connects to a trail along the north-side of the valley. Accessible restrooms are available at the backpackers’ parking lot and the backpackers’ campground, both of which are near the dam site on the south side of the valley.

Existing Recreation Facilities²³

Restrooms: There are three public restrooms in the Hetch Hetchy area. One is at a “comfort station” near a picnic area on the Hetch Hetchy Road, and two accessible restrooms are at the backpacker’s overnight parking lot and the backpacker’s campground.

Parking: There are four day-use public parking areas near the valley: at the ranger’s office near the Hetch Hetchy Entrance to Yosemite (which can accommodate 6-8 vehicles), at Inspiration Point along the Hetch Hetchy Road (which can accommodate 5-7 vehicles), at the “comfort station” (which can accommodate up to 10 vehicles), and at O’Shaughnessy Dam (which has 23 parking spaces). There is also an overnight parking lot at the backpackers’ campground (which can accommodate up to 30 vehicles). In addition, there are small parking areas at the trailheads to Smith Meadow and the Poopenaut Valley, each of which may fit 2-3 vehicles.

Campsites: There is one backpackers’ campground at the valley, which has 19 individual campsites, two group campsites, and two livestock campsites. The wilderness areas adjacent to the valley present many opportunities for backpacker camping as well.

Food Storage Lockers: There are 42 food storage lockers near the valley: 10 at the backpacker’s overnight parking lot, one at each of the individual camp sites, three for each group campsite, and two at the ranger’s office.

²¹ The current recreational use of the Hetch Hetchy Valley is discussed in detail later in this chapter under the heading Status Quo.

²² “Accessible” refers to areas that can be accessed by persons with physical disabilities, whereas “access” refers to issues pertaining to all visitors’ ability to access the site.

²³ Information provided by Yosemite National Park Rangers

Picnic Areas/Tables: There are four picnic areas with ten picnic tables in the area. The Poopenaut Pass has one picnic table, the Poopenaut View pullout has one picnic table, the “comfort station” has five picnic tables, and the area across from the day visitor parking area has three picnic tables.

Turnouts and Vistas: There are 19 turnouts and vistas along the road down to the dam site where visitors can pull over to allow other cars to pass, stop to rest, or to appreciate the views of the Poopenaut and Hetch Hetchy valleys.

Hetch Hetchy Recreation Alternatives

Future visitor participation in recreation activities at Hetch Hetchy Valley will vary depending on whether the reservoir is maintained in its current state (Figure C-1) or drained. The wilderness designation of the area is a major factor with significant influence on potential recreation patterns in the valley under any new use scenario. In addition, any proposal to expand recreation opportunities beyond those currently offered in the valley would likely require significant improvements in current limited access to the area.

The following sections briefly explore the two recreation alternatives for Hetch Hetchy Valley: status quo and increased recreation in the valley with the reservoir drained.

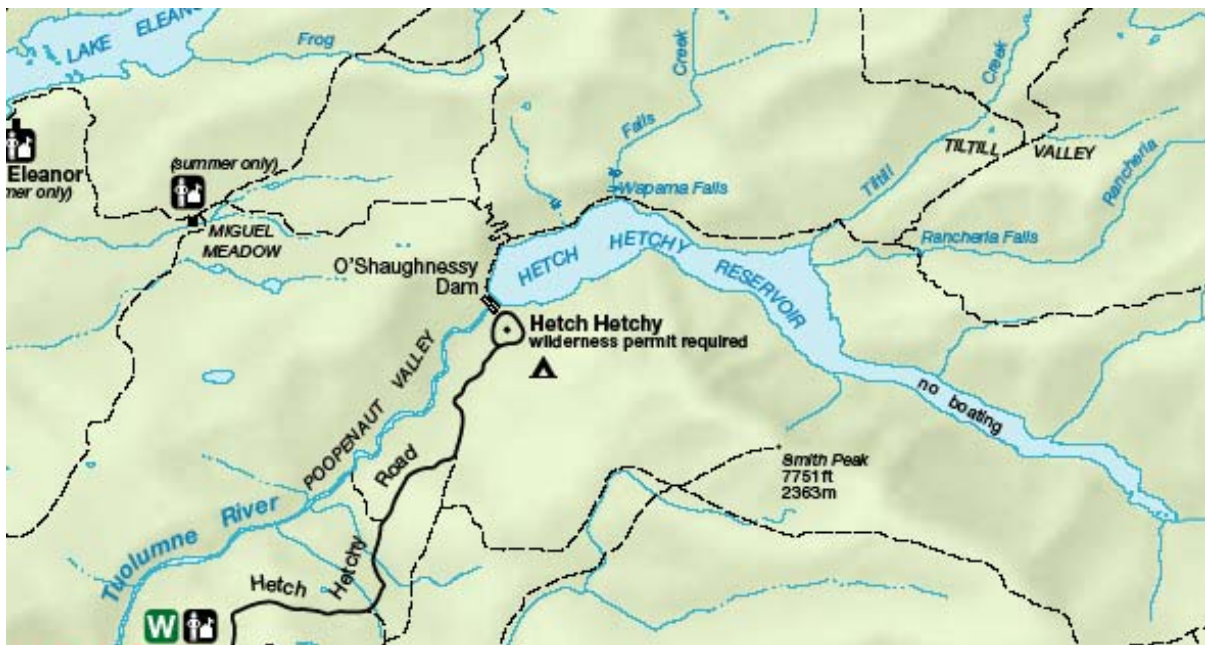


Figure C-1. Hetch Hetchy area

Status Quo Alternative

The current level of recreation available in Hetch Hetchy Valley is limited by the fact that the valley floor is under water and body contact recreation is not allowed on the reservoir. Body contact is not allowed in accordance with California drinking water statutes and the Raker Act because the reservoir is used as a primary drinking water supply for the San Francisco Bay Area.

Additionally, the NPS does not (and is not able to due to insufficient fiscal resources) actively promote visitation to the Hetch Hetchy Valley. However, there is evidence that some visitors to Yosemite National Park might be interested in a detour to the Hetch Hetchy area if they are made

aware of this resource. Several years ago, the official *Yosemite Guide* featured the Hetch Hetchy Valley. According to rangers present in the area at the time of the guide's publication, featuring the valley in the *Guide* caused visitation to the valley to increase that year from approximately 100 cars per day to 500 cars per day. In addition to this one-time surge in visitation, the annual Strawberry Music Festival at nearby Camp Mather causes an annual spike in visitation to the valley during the festival. These temporary increases in visitation suggest that if additional resources were available for staffing and promoting the valley, visitation would likely increase.

Opportunities for recreation: In a typical year, the peak visitation season to the valley is April through June. Visitation is less during other times of year due to weather (high summer temperatures and winter restrictions). According to NPS, visitation to the valley during this peak period averages approximately 100 cars per day. In the summer, visitation to the valley falls to 60-80 cars per day. According to NPS, the average vehicle occupancy at Yosemite is 2.9 persons per car.

Nearly all existing recreation in the Hetch Hetchy Valley is of a passive nature. Primary recreation activities in the valley include fishing (from the shore), hiking, backpacking, horseback riding, rock-climbing, and wildlife viewing. Body contact and boating activities are currently prohibited.

There are four trails that access the Hetch Hetchy Valley: the Poopenaut Valley Trail (1.5 miles), the Miguel Meadow Trail (7.5 miles), Lake Eleanor via the Miguel Meadow Trail (10.7 miles), and the Rancheria Falls Trail (6.7 miles)²⁴.

Drain Reservoir Alternative

Recreation in a restored Hetch Hetchy Valley would be constrained by the degree of development permitted within the valley. Additionally, as San Francisco would continue to divert water from the Tuolumne River even without the reservoir, measures would have to be taken to maintain water quality. Also, draining the reservoir would expose artifacts and remains from the native peoples that once inhabited the valley. Consequently, an assessment would be needed of the cultural resources in the valley, and these resources would need to be protected from theft, vandalism, or exploitation. The development possibilities in a post-reservoir Hetch Hetchy Valley range from a wilderness reserve with very limited development to a highly developed recreation area similar to Yosemite Valley. As mentioned previously, designated wilderness within the Hetch Hetchy Valley ends at the high waterline of the reservoir. Were the reservoir to be drained, the area below this high waterline would not face the constraints of the Wilderness Act. However, the NPS could (with Congressional action) designate such protections to extend below the high waterline and include the valley floor. In this segment two general concepts are considered for post-reservoir recreation: 1) a valley without wilderness protections, and 2) a valley with wilderness protections.

Without wilderness protections: There are a number of possible development options that could be explored in a Hetch Hetchy Valley without wilderness designation, ranging from minimal development to full development. For example, NPS could determine that a wilderness designation below the current waterline would hinder the restoration and management of the valley, and so might oppose such a designation for the area even though the actual degree of development in the valley would be minimal. Here we consider a scenario characterized by aggressive development in the valley as this effectively describes the “bookend” option to be considered in a restored, non-wilderness, Hetch Hetchy Valley.

²⁴ All distances are one way.

In 1988, the State Assembly Office of Research (AOR) stated in their analysis²⁵ of Hetch Hetchy restoration that, as a result of its small size, it would be impractical to attempt to develop the valley on a scale similar to Yosemite Valley. The analysis further concluded that if large-scale development were to take place to support access and recreation, visitor infrastructure such as a visitor center, hotels, campgrounds, cafeterias, restrooms, picnic areas, and interpretive centers would likely have to either be constructed on the Hetch Hetchy Valley floor or high above the valley floor. The report also mentioned development in the Poopenaut Valley just below the O'Shaughnessy Dam.

Additional access roads would be required to support a highly developed Hetch Hetchy Valley. The existing Hetch Hetchy Road terminates at the top of the O'Shaughnessy Dam. As suggested by the AOR study, this road would need to be extended to the valley floor.

Opportunities for recreation: This alternative use of Hetch Hetchy Valley could allow development of additional campsites (developed, primitive, stock, and RV/trailer), hardened surface or paved bike and walking paths, and additional opportunities to participate in other preexisting recreation activities in the valley, such as hiking, rock-climbing, horseback riding, and wildlife viewing²⁶. It is anticipated that picnic areas, trailheads, and interpretive panels would also be installed.

The narrow width of the valley (0.5 miles, half the width of Yosemite) could impede development of major structures should a subsequent plan call for this type of development. However, a relatively small visitor center and possibly small overnight facility could be accommodated. Parking, accessibility requirements, and egress and ingress to accommodate safety concerns would also need to be addressed. Access across the river (which would be presumed to be restored to its natural course) could impede development and human traffic flow.

With wilderness protections: If the reservoir was drained and the wilderness designation extended below the high water mark, almost no development would be permitted in the valley.

Opportunities for recreation: Minimum recreation development in the valley might still include appropriate restroom facilities, signage, trails, and possibly minimal picnic facilities. There may be additional trails for hiking, backpacking, horseback riding, and additional opportunities for rock-climbing. Mountain biking would not be allowed because bicycles are considered mechanized vehicles and are not allowed in designated wilderness areas. As operation of mechanized construction equipment is not allowed within wilderness areas, trails on the valley floor would need to be constructed by hand using primitive tools; completed before the wilderness designation for the valley is put in place; or specific provisions in the legislation authorizing the expansion of wilderness in the valley would have to exempt trail construction activities from the provisions of the Wilderness Act. Trail maintenance would also be restricted from using mechanized equipment.

²⁵ California Assembly Office of Research. (1988). *Restoring Hetch Hetchy*. (Publication No.0220-A). Sacramento, CA: Joint Publications Office.

²⁶ Further discussion of the recreation opportunities available in this use scenario can be found in Table C-1.

Table C-1. Current and potential Hetch Hetchy outdoor recreation uses

(Note- This table is meant to show a range of possible recreation uses. Any change to the status quo requires extensive further study, must be consistent with legal constraints, and in some cases may require changes to existing statute or policy)

Activities with High Latent Demand²⁷	Full Reservoir Current Use	Drained Reservoir: Rehabilitated Valley Floor With Wilderness Designation	Drained Reservoir: Rehabilitated Valley Floor Without Wilderness Designation
Camping at developed sites			X
Trail hiking	X	X	X
Walking	X	X	X
Wildlife Viewing	X	X	X
Bicycling: paved surfaces			X
Picnicking	X	X	X
Visiting outdoor interpretive displays	X	X	X
Visiting a historic or cultural site	X	X	X
Fishing	X	X	X
Camping at a primitive site	X	Possibly	X
Horseback riding	X	X	X
Driving for pleasure – scenic	X		X
Backpack Camping	X	X	X
Swimming – in a lake			
Bicycling – unpaved (mountain biking)			X
Paddle sports – kayaking, canoeing		X	X
Jogging	X	X	X
Rock climbing	X	X	X
Motor boating			
Sail boating/windsurfing			
Orienteering/geo-caching	X	X	X

Conclusion

Growth in the participation rates for many outdoor recreation activities combined with the growing number of Californians will put pressure on providers of recreation activities to make available additional opportunities. There are a number of possibilities for recreation and other public use activities in the valley. These alternatives include: allowing recreation in the valley to remain as it is now, leaving the reservoir in place but allowing water recreation, and draining the reservoir and restoring the valley. However, there will not be any changes to the status quo without first undertaking the required planning process, which includes extensive public input and, if needed, changes in public statute or policy.

Under either of the “with reservoir” or the “without reservoir” alternatives outlined above, recreational use of the Hetch Hetchy Valley could be expanded significantly should NPS choose to pursue changes in policy or statute. First and foremost, however, both of these options would likely require improved access and improved and expanded recreation facilities. With these enhancements,

²⁷ From *Public Opinions and Attitudes on Outdoor Recreation in California: 2002*, a 2003 publication by the California Department of Parks and Recreation, ranked in descending order based on a combined index of latent demand and public support.

recreational use of the Hetch Hetchy Valley under both alternatives would likely result in significant increases in the number of recreational users of the valley.

Increasing the recreation opportunities available in the valley would likely also have a positive economic impact on the communities in the area and strengthen Yosemite National Park's role as a primary economic engine for the communities in the central Sierra Nevada region of the state.

APPENDIX D. POTENTIAL IMPACTS OF A RESTORATION PROJECT

Impacts from Replacement of Water and Power Supplies

A key factor in assessing the feasibility of restoring Hetch Hetchy Valley is replacement of water and power supplies currently provided by O'Shaughnessy Dam and Hetch Hetchy Reservoir. According to Environmental Defense (2004):

“Any feasible alternative should:

- ensure a reliable supply of high-quality water to residents and businesses in the San Francisco Bay Area;
- include a plan to replace the hydropower that Hetch Hetchy Reservoir makes possible;
- ensure that the water and power benefits provided by the Tuolumne River to other communities, especially those served by the Turlock and Modesto Irrigation Districts, do not diminish.”

Alternatives for replacing water include components modifying, expanding, or reoperating existing reservoirs and conveyance facilities; constructing new facilities; developing new surface storage; developing a groundwater storage and retrieval system; implementing conjunctive use programs; as well as water use efficiency and water conservation programs.

Alternatives for replacing power include components modifying existing power plants; constructing new renewable or natural gas fired power plants; and implementing energy use efficiency and energy conservation programs.

Implementation of any of these components for replacement of water and power would result in both beneficial and adverse impacts to the environment outside the Hetch Hetchy Valley itself. While removal of O'Shaughnessy Dam may provide numerous ecological, aesthetic and recreational benefits within Hetch Hetchy Valley, the focus of this appendix is to present an overview of the potential impacts that may result outside the Hetch Hetchy Valley due to replacement of water and power supplies. No attempt is made to quantify the intensity or scope of the impacts since such an analysis is not possible without information on specific proposed project locations, facilities and operations. For this same reason, specific mitigation measures are not proposed or discussed.

Projects Proposed to Replace Water and Power Supplies

Alternatives for replacing water and power supplies can be grouped by geographic area, as follows:

Hetch Hetchy System Area and Tuolumne River above Don Pedro Reservoir

- Enlargement or modifications to Cherry and/or Eleanor reservoirs.
- Modifications to Kirkwood, Holm and/or Moccasin powerhouses.
- Construction of new water and power supply facilities.

New Don Pedro Reservoir to Confluence with San Joaquin River

- Enlargement of Don Pedro Reservoir.
- Construction of an intertie to the Hetch Hetchy Aqueduct.
- Use of groundwater storage and supplies.

Sacramento-San Joaquin Delta

- Construction and operation of new surface storage within the Central Valley.
- Construction and operation of a California Aqueduct intertie.
- Expansion of the South Bay Aqueduct.
- Construction and operation of a Delta-Mendota Canal intertie.
- Construction and operation of conventional or alternative energy facilities (e.g. gas fire-powered plants); wind, solar and geothermal energy.
- Implementation of conjunctive use programs; use of groundwater storage and supplies.

Greater Bay Area

- Expansion of Calaveras Reservoir.
- Expansion of Los Vaqueros Reservoir.
- Expansion of Sunol Water Treatment Facility.
- Construction and operation of a new water treatment facility.
- Implementation of groundwater and water use efficiency programs; waste water recycling.
- Implementation of energy efficiency and energy conservation programs.

Discussion of Potential Impacts

Most of these alternatives would involve, among other things, construction and excavation. Thus, for the purposes of this analysis, this broad category of impacts will be described as “earth-moving activities”. Removal of O’Shaughnessy Dam, re-establishment of natural flow, subsequent changes to water conveyance, and variations due to water year type could result in changes to flow and water quality. Thus, another broad category of impacts is “changes to flow and water quality”. Two other categories of impacts are those resulting from operation of alternative energy facilities and from water and energy use efficiency and conservation. These four categories are discussed below.

Earth-moving Activities

Construction of new water and power supply facilities or enlargement/modifications to existing reservoirs and powerhouses would involve substantial “earth moving” and could result in both permanent and temporary impacts. These potential impacts include:

- **Aesthetics and Recreation:** Construction activities could adversely impact the scenic and recreational value of these areas.
- **Air Quality, Traffic, and Noise:** Temporary impacts due to construction activities could reduce local air quality, and increase traffic and noise.
- **Cultural resources:** Construction activities could adversely impact historical and cultural resources in the area.
- **Habitat:** Construction activities could adversely impact habitats, such as grasslands, oak woodlands, chaparral, wetlands, and riparian corridors.
- **Sensitive plant and animal species:** Construction activities could directly impact sensitive plant and animal species in the construction area, causing injury or death. Construction activities could also impact sensitive species indirectly by altering habitat, blocking migration corridors, and decreasing prey base.

Sensitive species which could be impacted by construction activities in the four geographic areas include:

- **Hetch Hetchy System and Tuolumne River above Don Pedro Reservoir:** valley elderberry longhorn beetle (FT²⁸), California tiger salamander (FT), California red-legged frog (FT), mountain yellow-legged frog (FE), bald eagle (FT, SE), great gray owl (SE), San Joaquin kit fox (FE, ST), and Sierra Nevada red fox (ST), among others.
- **Don Pedro Reservoir to the Confluence of the Tuolumne and the San Joaquin Rivers:** valley elderberry longhorn beetle (FT), California tiger salamander (FT), California red-legged frog (FT), bald eagle (FT, SE), tricolored blackbird (SSC), Swainson's hawk (ST), San Joaquin kit fox (FE, ST), Chinook salmon (FE/SE, FT depending on run), steelhead (FT) among others.
- **Sacramento-San Joaquin Delta and Central Valley:** valley elderberry longhorn beetle (FT), giant garter snake (FT, ST), Swainson's hawk (ST), greater sandhill crane (ST), California black rail (ST), San Joaquin kit fox (FE, ST), San Joaquin pocket mouse (FSC), Chinook salmon (FE/SE, FT depending on run), steelhead (FT), delta smelt (FT, ST), and western pond turtle (FSC, SSC), among others. It should also be noted that parts of the Delta are designated as critical habitat for winter- and spring-run Chinook, steelhead and delta smelt.
- **Greater Bay Area:** Bay checkerspot butterfly (FT), steelhead (FT), California tiger salamander (FT), California red-legged frog (FT), Alameda whipsnake (FT, ST), San Francisco garter snake (FE, SE), western snowy plover (FT), California clapper rail (FE, SE), and salt marsh harvest mouse (FE, SE), among others.

Impacts of Changes to Flow and Water Quality

Removal of O'Shaughnessy Dam and modifications to existing reservoir operations would cause changes to flow and water quality and could result in the following potential impacts:

- **Aesthetics:** Reductions in flows during summer and fall months could adversely impact the scenic and recreational value of the areas.
- **Agriculture:** During dry years, low flows could result in less water being available to water rights holders in the Delta, including agricultural interests. This could adversely impact agriculture. Additionally, groundwater or conjunctive use programs could adversely impact the water supply to agricultural interests.
- **Aquatic Habitat in the Tuolumne:** In 1984, 83 miles of the Tuolumne River, from the headwaters above Hetch Hetchy to Don Pedro Reservoir, were federally designated as a National Wild and Scenic River. Only Hetch Hetchy Reservoir and the area around Kirkwood Powerhouse, an 8-mile stretch, were excluded from this designation. The purpose of this designation is to afford protection to relatively pristine river systems, preserving their free-flowing condition and, ultimately, their character. Removal of O'Shaughnessy Dam would restore the character of the river and might enable this 8-mile stretch to be added to the Wild and Scenic River System. This would be considered a beneficial impact. Restoration of the natural flow regime to the Tuolumne River could result in adverse impacts to fish. While natural winter and spring flows would be higher than the current managed flows, natural summer flows could subside to 50 cubic feet per second (cfs) or less during August and September (USBR 1988). Thus, with restoration of Hetch Hetchy

²⁸ FT = Federal Threatened; FE = Federal Endangered; FSC = Federal Species of Concern; SE = State Endangered; ST = State Threatened; SSC = State Species of Concern

Valley, current summer/fall fishery flows would not be maintained in all years (USBR 1988). Lower summer flows could adversely impact the trout fishery in the Tuolumne River below Early Intake Reservoir.

Aquatic Habitat in the Sacramento-San Joaquin Delta: Impacts to aquatic habitat in the Delta would vary based on flow conditions, water year type, and water storage and conveyance replacement scenario. For example, during wet years, the high flow and pristine condition of the water from the Tuolumne River could improve water quality in the Delta. If increased diversions from the Delta are required to meet SFPUC needs, during below normal and dry years, sensitive fish and other aquatic organisms could be adversely impacted by low flow conditions. Such conditions could result in decreased quality and quantity of habitat, food availability and lower water quality (e.g., higher pollutant concentrations and lower dissolved oxygen). Additionally, low flow conditions could weaken the system ecologically, making it more susceptible to invasions by exotic species. For example, decreased zooplankton populations could result in decreased year class strength of certain native fish species, making the system vulnerable to invasion by a non-native species.

Fish could also be directly impacted by increased pumping, reverse flows, impingement and entrainment of fish in pumps (USBR 1988). Such activities could result in mortality and significantly affect sensitive fish populations.

Sensitive aquatic species that could be impacted by changes to flow include Chinook salmon, steelhead, delta smelt, and western pond turtle, among others. It should also be noted that parts of the Delta are designated as critical habitat for winter- and spring-run Chinook, Central Valley steelhead and delta smelt.

Wetland and riparian habitats in the Delta would benefit from higher flows during above normal to wet years. Increased quality and quantity of habitat would benefit associated species. Likewise, during dry or critical years, low flow conditions could adversely affect habitat quantity and quality. Lower flows would result in lower inundation in wetlands, decreased water quality and food availability, and could adversely impact associated species.

Sensitive riparian and wetlands species of the Sacramento San Joaquin Delta that could be impacted by changes in flow include: delta mudwort, delta tule pea, Mason's lilaeopsis, rose mallow, valley elderberry longhorn beetle, giant garter snake, greater sandhill crane and California black rail, among others.

- **Aquatic Habitat in the Greater Bay Area:** Expanding Calaveras Reservoir could result in adverse impacts to sensitive species if flooding of tributary streams occurs. These tributary streams provide spawning and rearing habitat for native steelhead and are habitat for California red-legged frog, Alameda whipsnake and other sensitive species (Alameda Creek Alliance 2002). Further, introduction of Tuolumne River water into the Alameda Creek system may impact native steelhead in the creek (RHH 2005)
- **Recreation on the Tuolumne River and at Don Pedro Reservoir:** Some reaches of the Tuolumne River are extensively used for white-water rafting during the summer and fall. Rafting could be adversely impacted during these seasons by normal flows, which can decrease to less than 50 cfs during these seasons (USBR 1988).
Recreation at Don Pedro Reservoir could also be impacted by revised dam operations. During summer and fall of dry years drawdown could be extensive and could adversely affect recreational activities at the reservoir.

- **Water Quality:** Impacts to water quality would vary based on flow conditions, water year type, and water conveyance scenario. During wet years, the high flow and pristine condition of the water from the Tuolumne River could improve water quality in the Delta. During dry and critical years, water quality in the Delta would suffer (as it typically does during dry years) due to low flows, high concentrations of contaminants, and low dissolved oxygen.
- **Flooding:** O'Shaughnessy Dam and Hetchy Hetchy Reservoir provide incidental flood control benefits that would be lost with removal of the dam.

Operation of Conventional and Alternative Energy Facilities

Increased operation of various types of power plants (i.e., natural gas, wind, solar, geothermal) could result in either adverse or beneficial impacts to the environment, including:

- **Air Quality:** Increased operation of natural gas power plants would result in adverse impacts to air quality. However, this technology is less polluting than other non-renewable sources of energy.
- **Plants, Wildlife, and Habitat:** In general, reliance on alternative sources of energy, such as wind, solar, and geothermal, is better for the environment, since these sources are non-polluting and renewable. Thus, operation of alternative energy facilities could be beneficial to the environment in the long-run.

One specific adverse factor related to generation from wind is the potential for birds, such as raptors, to be injured or killed by collisions with moving turbine blades (Environmental Defense 2004).

Water and Energy Use Efficiency and Conservation

Implementation of water and energy use efficiency programs and conservation programs could result in beneficial impacts, including:

- **Plants, Wildlife, and Habitats:** Water and power efficiency and conservation would benefit the natural environment by decreasing use of natural resources that decreases impacts to plants, wildlife, and habitats. Implementation of such programs benefits the natural environment in the long run.

Mitigation Strategies

Mitigation strategies are necessary to reduce the severity of direct, indirect, and cumulative impacts. Mitigation strategies generally consist of safeguards by law, regulation, or contract; physical measures; and other management programs. Any action-specific mitigation will be identified by site and action-specific analyses.

Water Quality Implications

Specific impacts to water quality due to the restoration of Hetch Hetchy Valley are impossible to predict at this time, because they would be highly dependent upon flow conditions, water year type, and water supply replacement scenario. For example, if Lakes Cherry and Eleanor, currently stand-by sources for the SFPUC, were instead used regularly for domestic water supply, water quality could remain very high, depending particularly upon the levels and types of recreation permitted. Alternatively, should the Sacramento-San Joaquin Delta become a replacement water source, some level of advanced treatment, likely involving membranes, would be required to achieve, at least quantitatively, an equivalent level of water quality. Likewise, groundwater as a replacement water supply for Hetch Hetchy would also require treatment, at least for aesthetic concerns. Impacts to

the water quality of the upper Tuolumne River are also dependent upon the specific restoration and public use plans implemented for Hetch Hetchy Valley, which do not currently exist. For instance, a public use plan that limits and controls public access to a restored Hetch Hetchy Valley could be protective of the upper Tuolumne's superior water quality.

In general, though, the two replacement water sources most often mentioned in conjunction with the restoration of Hetch Hetchy Valley—Don Pedro Reservoir and the Sacramento-San Joaquin Delta—are fully capable of producing water of potable quality, and the latter already does so for more than 20 million Californians. While there are currently no large public water systems that use Don Pedro Reservoir directly as a domestic water source, Modesto Irrigation District (MID) treats Tuolumne River water impounded in Modesto Reservoir, located downstream of Don Pedro and La Grange Dams, for the City of Modesto and neighboring communities.²⁹ The Modesto Regional Water Treatment Plant is a conventional filtration plant that utilizes ozonation and chlorination for disinfection. For the Sacramento-San Joaquin Delta source, Treatment Plant No. 2, operated by the Alameda County Water District (ACWD), is representative of state-of-the-art facilities that treat Delta water.³⁰ It, too, is a conventional filtration plant, which uses ozonation and chloramination for disinfection.

A review of water quality data for 2004, as self-reported by these utilities, shows that treated water from both these sources met all drinking water standards, as did Hetch Hetchy.³¹ In fact, none of the three subject utilities surveyed—SFPUC, City of Modesto, and ACWD—reported any detection of contaminants commonly of public interest, such as arsenic, pesticides, industrial chemicals, methyl tertiary-butyl ether (MTBE), chromium, and perchlorate, in 2004. Further, regulated disinfection by-product concentrations were below the newly promulgated standards for all three utilities.

However, beyond strictly quantitative comparisons, these three water sources differ greatly in other respects. For example, both Don Pedro and the Delta are vulnerable to more “possible contaminating activities” (as reported by the Department of Health Services’ Drinking Water Source Assessment Program) than is Hetch Hetchy. In particular, the Delta receives drainage from the Sacramento and San Joaquin river watersheds, which includes extensive urban and agricultural runoff, as well as urban and industrial wastewater discharges and pollution from boats and ships. These two water sources also do not have the watershed control that is ensured by Hetch Hetchy’s presence in a national park and the sanitary regulations of the Raker Act. Because of this level of control, contaminants that are currently unregulated or “emerging” are unlikely to be present in the Hetch Hetchy watershed. However, with such a greater number and variety of pollution sources in the watersheds of Don Pedro and especially the Delta, these contaminants could exist in these water sources, posing a potential risk to public health, even if they have not actually been detected. In this respect, much like a restored Hetch Hetchy Valley, the value of a protected watershed, while certainly real, is nonetheless difficult to quantify in terms of economics or even water quality.

²⁹ Ironically, as opposed to Hetch Hetchy, the State of California has granted Modesto Reservoir an exemption from the Health and Safety Code section that prohibits body contact recreation in reservoirs used for domestic water supply.

³⁰ Treatment Plant No. 2 is fed from the South Bay Aqueduct, just downstream from where SFPUC currently has a turnout from the State Water Project.

³¹ This data is not necessarily representative of variations due to seasons, differing hydrologic conditions, or specific events.

While treatment could be implemented for a replacement water source or even for the upper Tuolumne River, there are tradeoffs and impacts involved with this option.³² The fundamental question is whether filtration is added as a complement to, or a replacement for, watershed protection. That is, filtration as a supplement to watershed protection would certainly add an additional barrier to pathogens and could improve overall protection of public health. However, trading filtration for a lower level of watershed protection may not result in an overall improvement in public health protection, and, in fact, could possibly endanger it. Moreover, the often unseen operating details of filtration involve such things as chemical transport, handling, and use; the addition of dissolved solids to the water supply; more treatment residuals and thus wastewater; risks to treatment plant operators; and ongoing operations and maintenance costs, including those related to pumping.

Changes in treatment and water source will also affect distribution system water quality in various ways. In addition, industrial users, who often require a water quality even better than potable, could be affected as well by a change in water source and treatment, in that their own on-site treatment facilities would need to be changed, upgraded, or used more frequently to treat a different water quality. Changes in aesthetics due to changes in source or treatment may also affect the acceptance of tap water by the general public (e.g., a public accustomed to a certain taste of tap water may question the safety of a tap water of a different taste, even if the issue is solely one of perception). In all, the impacts to drinking water quality resulting from the restoration of Hetch Hetchy Valley are complex, deserve careful consideration, and cannot necessarily be solved by simply implementing a black box called filtration.

Whereas nearly the entire discussion of water quality during the recent Hetch Hetchy debate has focused on drinking water, any change to the current conveyance regime will change water quality conditions in the rivers downstream of the valley as well. For instance, the high flow and pristine condition of the water from the Tuolumne River, if not diverted from the watershed at Hetch Hetchy, could markedly improve water quality in the lower Tuolumne, San Joaquin, and the Delta during certain times of the year. With an expansion of Don Pedro Reservoir, though, less spill from this facility would reduce water flowing to the lower Tuolumne and the Delta to dilute contaminants. Alternatively, the salinity and dissolved oxygen impairments of the lower San Joaquin River are particularly sensitive to flows, or changes in the timing of high quality Tuolumne River water, which affect the assimilative capacity of the River. For comparison, Reclamation has historically released water from New Melones Reservoir, on the nearby Stanislaus River, to help meet water quality standards in the south Delta.

Process of Dam Removal/Restoration Projects

Approaches to dam removal issues have been prepared by nonprofit foundations. The reports examined dam removal issues, especially as they relate to watershed management. Although the reports addressed the removal of relatively small dams, they offer insights into the issues that must be considered before removing any dam and ways to manage the deliberative process.

The Aspen Institute (2002) provides the most relevant information on the deliberation process. The organization invited a group of experts to address questions related to the possible removal of dams as an option for river system management. The group met over a two-year period and

³² In 1995, DHS conditionally approved SFPUC's proposed design criteria for a Hetch Hetchy Water Treatment Plant, which would utilize a high-rate, direct filtration treatment train with deep-bed monomedia filters. While no cost estimate accompanied that conceptual plant, in 1991 the SFPUC did estimate the capital cost of a Hetch Hetchy treatment facility (one not utilizing high-rate filtration) at \$487 million (in 1995 dollars), with another \$14 million (in 2010 dollars) in ongoing operations and maintenance costs.

considered, among other issues, what can be done to improve policy and decision-making as well as public involvement in the deliberations.

The H. John Heinz III Center for Science, Economics, and the Environment has also published two reports on dam removal issues. The center's two reports were an outgrowth of a program initially funded by the Heinz Center, the Federal Emergency Management Agency, and the Electric Power Research Institute. The first report summarized the impacts of dam removal and offers suggestions for bringing science to bear on the decision-making process once dam removal becomes a realistic option. The second report is a compilation of presentations made at a workshop on dam removal that attempts to identify the environmental, economic, and social impacts of dam removal that require further analysis. It notes that although over 400 dams have been removed in the United States, little is known about the ecological consequences of the removal.

Below is a brief description of those issues addressed in these reports that relate to project management as opposed to technical matters.

- **Address the rights of dam owners and beneficiaries at the outset.** The Aspen Report (2002) includes a discussion of the importance of clarifying the rights of owners and beneficiaries at the beginning of the decision-making process. Further, it notes the importance of honoring legal contracts and applying fair principles for determining whether and how to make parties whole.
- **If new studies are necessary, take key steps up front.** The steps include identifying the full spectrum of issues, agreeing to analytic tools and related assumptions, and determining who will do the work. It also involves identifying the legal and regulatory requirements early in the process and consulting with the appropriate regulatory officials. These analyses should be performed early because they are key to estimating both cost and technical feasibility.
- **Revise permitting requirements to accommodate dam removal.** Often regulatory reviews do not account for the benefits of projects. In the case of a proposed dam removal, this can preclude consideration of the extent to which restoration benefits, which may be long-term by their nature, outweigh the short-term impacts of a dam removal. Also, it is important to ensure that inflexible permitting requirements do not result in “over-engineering of removal methods or final site design.”
- **Coordinate the applicable regulatory programs.** Dam removal often involves multiple agencies, complicating deliberations and permitting. The report suggests developing memoranda of understanding between the state and federal agencies to streamline the permit review process.
- **Make dam removal activities eligible for funding from existing programs and seek private funds.** The Aspen Report notes that existing state and federal programs such as those related to water and watershed management, fish and wildlife management, water quality assessment, and dam safety, sometimes provide monies that could appropriately be applied. These funds may include tax incentives, corporate donations, and private funds.
- **Consider creative regulatory approaches.** The Aspen Report suggests coming up with creative regulatory approaches such as allowing dam removal to serve as environmental mitigation for other water projects.

References

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- Environmental Defense. 2004. *Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley*. Oakland, CA. 116 p. plus appendices.
- Restore Hetch Hetchy. 2005. *Restore Hetch Hetchy: Finding the Way Back to Hetch Hetchy Valley*. Sonoma, CA. 86 p.
- U.S. Bureau of Reclamation (USBR). 1988. *Hetch Hetchy: A Survey of Water and Power Replacement Concepts*. Prepared on behalf of the National Park Service by the Bureau of Reclamation, Mid-Pacific Region. Sacramento, CA. 32 p. plus appendices.

Personal Communications

- Alameda Creek Alliance. 2002. Letter to Paula Kehoe, SFPUC, Regarding: SFPUC Capital Improvement Program—Calaveras Dam. April 18, 2002. 3 p.

APPENDIX E. OTHER ISSUES

Cultural Resources

The draining of the reservoir and the restoration of Hetch Hetchy Valley will trigger compliance with various cultural resources laws and regulations regardless of the level of restoration effort. Because the valley is federally owned property, the most significant law is the National Historic Preservation Act (NHPA) and its implementing regulations under 36 CFR 800, as amended. Section 106 of the NHPA states that, prior to the implementation of a project or undertaking, the federal government (or other designated lead agency) must “take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register [of Historic Places].” The implementing regulations outline several key steps required in the compliance process. These include (1) identification of an Area of Potential Effects (APE) for the project; (2) identification of all cultural resources within the APE that are eligible for inclusion in the National Register; and (3) mitigation of any adverse effects to those eligible resources that result from project implementation.

Delineation of the APE for the proposed restoration could be problematic since the reservoir is a part of a much larger system of water conveyance and delivery. Consultation with the State Historic Preservation Officer may help determine whether the APE should include the entire system or only those portions that will be directly affected. Once an APE has been determined, an inventory of all cultural resources would proceed, followed by an evaluation of those resources for significance and eligibility to the National Register.

Some data is currently available about archaeological sites present in Hetch Hetchy Valley. Seven prehistoric archaeological sites were recorded around the edge of the reservoir by University of California, Berkeley in 1951 (Montague and Mundy 1995:5). An additional 10 archaeological sites were recorded by National Park Service archaeologists in 1991 when the reservoir level fell to its lowest elevation since its original inundation (Montague and Mundy 1995). All of the sites contain prehistoric components, while three of the sites also include historic elements and one site reflects occupation by Native Americans during the historic era. Eleven isolated artifacts or features were also recorded during the National Park Service study; four were prehistoric isolates and seven were from the historic era.

Cultural resources, other than archaeological sites, within the APE would also require recordation and evaluation, including traditional cultural properties (TCPs) and the dam and hydroelectric facilities. It is likely that the entire valley would be considered a TCP given the importance of the area to descendants of the Native Americans inhabiting the valley at the time of Euro-American contact. Furthermore, O’Shaughnessy Dam and the Hetch Hetchy system are probably eligible for listing in the National Register.

If Hetch Hetchy Reservoir is drained, surface water storage at other locations may be required as water supply replacement. Cultural resource studies pursuant to Section 106 of the NHPA would be required for those areas that would be newly inundated in addition to lands modified to accommodate infrastructure features (new roads, moved recreation facilities) related to increased high water levels.

Avoidance of impacts is always the preferred course of action, but if impacts cannot be avoided, mitigation of project effects on those resources eligible for the National Register of Historic Places is required. Such mitigation measures would vary according to the individual resource and

might range from application of a protective layer or data recovery excavations for archaeological sites, to a detailed recording of structural features for the Historic American Buildings Survey or the Historic American Engineering Record.

One of the most significant elements of the January 2001 amendments to the NHPA implementing regulations at 36 CFR 800 was the increased coordination with federally recognized Indian tribes. These amendments require consultation with tribes during all phases of an undertaking from the identification and evaluation of cultural resources through decisions on mitigation efforts for properties eligible for the National Register.

Numerous federally recognized tribes and tribes without federal recognition have traditional ties to Hetch Hetchy Valley. These tribes reside on both sides of the Sierra Nevada and include the Tuolumne Band of Me-Wuk, the Southern Sierra Miwuk (American Indian Council of Mariposa County), the North Fork Band of Mono Indians, the Bridgeport Paiute Indian Colony and the Mono Lake Indian Community. To better understand Native American issues related to restoring Hetch Hetchy Valley, DWR met with approximately 20 Native American representatives on March 29, 2005, in Tuolumne, California.

A wide variety of opinions were expressed by meeting participants. Generally, the group tended to favor maintaining the reservoir because the water protects their ancestral sites and there is evidence that when the water level does fall, looting of the sites becomes a problem. However, should the reservoir be drained, participants were adamant about the need for the tribes to be thoroughly involved in the decision to drain and manage the land. Opinions ranged from returning full ownership of the land to the native tribes, to maintaining the valley as a national wilderness area open to the public, to allowing limited developed recreation in the valley. Several issues were particularly important: 1) development in the valley should be very limited to avoid duplicating the level of development found in Yosemite Valley, 2) recreation should be restricted to low impact activities, 3) restoration of native plants, wildlife and springs should be a priority, and 4) the tribes should be provided access to ceremonial grounds. The tribes expressed a desire participate fully in the management of any recreational development, including providing law enforcement and protection of resources. Tribal participants called for a full inventory of cultural resources in the valley if Hetch Hetchy is drained, and that any areas to be inundated at other locations be surveyed for cultural resources.

The above was expressed by representatives of Native Americans on the west side of the Sierra Nevada. A similar solicitation of thoughts and opinions from tribes east of the Sierra crest also needs to occur due to their demonstrated ancestral ties to Hetch Hetchy Valley.

Incidental Flood Control

Hetch Hetchy Reservoir provides indirect flood control benefits on the Tuolumne and lower San Joaquin rivers. There is no formal requirement to maintain flood control space in Hetch Hetchy Reservoir. Reservoir operators normally keep some space during winter months for operational flexibility and to avoid losing power production if there is a winter storm that could force spills beyond the Kirkwood Powerhouse hydraulic capacity (about 1,400 cubic feet per second). Indirectly this provides some additional flood control on the Tuolumne River beyond that of Don Pedro Reservoir alone. The U.S. Army Corps of Engineers requires 340,000 acre-feet (af) of winter rain flood space in Don Pedro from October 7 through April 27, with partial requirements starting after September 8 and ending by June 3. In addition, during a big snowpack year, there can be a conditional reservation of up to 1,000,000 af total space. A small amount of this conditional

snowmelt reservation, up to 50,000 af, can be “transferred” if there is enough empty space in Hetch Hetchy and Cherry Valley. The Hetch Hetchy portion of this is limited to 35,000 af (70 percent of 50,000) and is also limited to 80 percent of the empty space for this purpose. No transfer is permitted of the rain-flood reservation.

Table E-1 gives the indirect effect of Hetch Hetchy and Cherry Valley storage during the seven biggest three-day flood events on the Tuolumne River, ranked by size. All of these floods were during the last half of the 20th century. Cherry Valley Dam (Lake Lloyd) was completed in 1956; there may have been a little temporary storage of the December 1955 flood. In addition there has been some storage during these floods at the smaller Lake Eleanor, averaging around 15 thousand af in the same storms. New Don Pedro Dam was completed in 1971. The Tuolumne record is one of the longest in California, starting in water year 1897.

Table of largest storms effects on Tuolumne River

Data is from the U.S. Army Corps of Engineers’ *Comprehensive Flood Study of the Sacramento and San Joaquin River Basins*.

Table E-1. Effects on Tuolumne River from the largest storms

Water year and dates	Three-day runoff rate in 1,000 cfs	Hetch Hetchy	Cherry Valley
		storage gain in taf	
1997: Jan 1-3	92.1	86.1	80.5
1956: Dec 22-24, 1955	71.3	87.2	under construction
1951: Nov 18-20, 1950	53.4	104.2	not built
1965: Dec 23-25, 1964	51.5	93.2	60.0 est.
1986: Feb 17-19	49.6	25.6	25.1
1980: Jan 12-14	45.1	50.0	41.4
1963: Jan 31-Feb 2	41.5	45.9	46.0

In late 1996, operators increased Hetch Hetchy releases on December 29, lowering Hetch Hetchy about 25 taf by December 31 to 261 taf. This added inflow to the already encroached Don Pedro Reservoir prior to the big storm and reduced the overall effective storage benefit to 56 taf for the event. In all the years except 1997, Don Pedro controlled or would have controlled the downstream releases to near the objective target flow at the Modesto gage of 9,000 cubic feet per second (cfs). This conclusion is confirmed in a May 2005 report by MBK Engineers, *Assessment of the Flood Control Impacts of the Removal of Hetch Hetchy Dam and Reservoir, Tuolumne River, California*. Without upstream indirect flood storage, the threshold of control would be a three-day rate slightly over 50,000 cubic feet per second at Modesto. Historically, combined upstream storage seems to have provided at least 120,000 af of incidental benefit which would control another 20,000 cfs, raising the controllable total three-day natural runoff to around 70,000 cfs, about the December 1955 storm amount. The above table indicates big enough events to claim that Hetch Hetchy storage helped four times in the last century. It definitely helped in 1997. MBK concluded that the maximum Don Pedro release would have been about 100,000 cfs compared to the actual 59,000 cfs recorded in the flood. (According to the USGS, the maximum flow at Modesto was 55,800 cfs with a peak stage of 71.2 feet.) A 41,000 cfs increase without Hetch Hetchy would probably raise the peak stage at La Grange nearly 8 feet higher than it was.

MBK also estimates that the maximum release from Don Pedro in a repeat of the December 1955 flood without Hetch Hetchy would be about 25,000 cfs, assuming the reservoir started at the flood control pool level at the beginning of the storm. However, in the historical 1955 flood,

because the previous 1955 water year was dry, one would expect the reservoir level to be significantly lower in mid-December that year, perhaps by 250,000 af and therefore Don Pedro Reservoir likely would have had enough extra flood capacity to handle that storm.

To summarize, the incidental flood storage in Hetch Hetchy reservoir in a large flood is likely to be in the 60 to 70 thousand acre-feet (taf) range. There is about an equal amount in Cherry Valley and Lake Eleanor. The existing flood risk in the lower Tuolumne River is quite high. According to the Comprehensive Study (USACE 2002), the current Don Pedro rain-flood reservation of 340 taf with 9,000 cfs objective flow provides about 1-in-30-year protection. Adding in 130 taf for the average incidental storm catch in the upstream three reservoirs increases protection to about the 1-in-50-year level. Taking out the 60 to 70 taf estimated above for Hetch Hetchy Lake reduces available basin flood storage to around 400 taf with about a 1-in-40-year level of protection. To get a 1-in-100-year level of lower Tuolumne River protection with the present 9,000 cfs objective flow at Modesto would require about 610 taf of effective flood control space.

Snowmelt water in the early spring is not always storable in Dan Pedro Reservoir. The rain flood space requirement currently extends to April 27. The rain-flood reservation at nearby New Melones starts decreasing after March 20 and starts decreasing at New Exchequer in mid March. It is doubtful that the rain flood risk in March is as great as the midwinter December-February period; certainly in April there would be less risk. This water supply benefit would apply with or without Hetch Hetchy, but would be more important without Hetch Hetchy. The current full rain-flood reservation by October 7 is probably not needed, either, but it may be desirable to be at that level to reduce big flow fluctuations downstream in the fall for the sake of the fishery.

References

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- U.S. Army Corps of Engineers (USACE). 2002. Sacramento and San Joaquin River Basins Comprehensive Study: Technical Studies Documentation. Department of the Army, Sacramento District. CA. avail. <http://www.spk.usace.army.mil/projects/civil/compstudy/reports.html>

APPENDIX F. WATER MANAGEMENT MODELING

Some good work has been done on modeling of the existing Hetch Hetchy system, as well as modeling of water and power replacement options for the restoration of Hetch Hetchy Valley. However, researchers have not evaluated statewide water management impacts or established performance criteria to measure success. Perhaps most noteworthy, a major element missing from the existing studies is a public involvement process to engage the public, agencies, and stakeholders in determining the purpose and need of the project, establishing objectives, and grappling with potentially adverse regional and third-party impacts that might result from options involving water and power changes. Future studies need to develop well-defined objectives, supported by a robust stakeholder process.

The modeling work completed to date is at the “concept-level” of detail. To put some perspective on the level of detail of modeling completed to date, the state’s view of accepted modeling practice for different types of studies (i.e., concept-level, appraisal-level, feasibility-level, site-specific studies, or economic analysis) is explained here. The concept and appraisal levels of study may only require simplistic modeling or spreadsheet analysis to compare the relative performance of a project component or one alternative with another. However, for feasibility-level, site-specific studies, or economic analysis, more detailed modeling is required to make decisions on facility sizes and operations and for selecting a preferred alternative for the project. In particular, these studies may require system modeling for sizing and combining facility components, optimizing reservoir/conveyance operations, determining water quality impacts, evaluating power use and generation, and simulating water rights or institutional constraints. For environmental and economic impact analyses, resource evaluation models may be applied in conjunction with system modeling.

This appendix describes the existing modeling work, as well as how that modeling was used in the state’s cost estimate.

Existing Modeling Studies

Of all the published works on restoring Hetch Hetchy Valley, only two included modeling as a basis for their Hetch Hetchy water and power replacement evaluations: U.C. Davis (Sarah Null) and Environmental Defense (ED). Table F-1 includes a summary of water management alternatives and related assumptions as modeled by U.C. Davis and ED. Modeled alternatives for replacing water include components modifying, expanding, or reoperating existing reservoirs and conveyance facilities; constructing new facilities; developing new surface storage; developing a groundwater storage and retrieval system; and implementing conjunctive use programs.

The U.C. Davis modeling takes an academic approach to the question of whether the SFPUC could live without Hetch Hetchy Reservoir, focusing on an intertie to Don Pedro Reservoir supplemented by dry-year purchases from the agricultural sector. Null utilized an engineering-economic optimization computer model of California’s water systems called “CALVIN”, which was run using projected urban and agricultural demands for 2020 and 2100.

Table F-1. Assumed parameters for water supply and power management scenarios modeled in past studies

Study Organization		Water Management Components																								
		Upper Tuolumne System (Including local SFPUC system)								Lower Tuolumne System (Including local MID/TID)						Outside/Bay-Delta System (Water and Power Options)						Other Modeling Assumptions				
		O'Shaughnessy Dam (TAF)	Cherry/Eleanor Storage and Reoperation (TAF)	New/Enlarged Storage on Tuolumne River (TAF)	San Joaquin Pipeline Capacity (CFS)	Calaveras Reservoir Volume (TAF)	Other Enlarged Storage (TAF)	Conservation and Efficiency Measures	Tuolumne River Diversion Modifications	Don Pedro Interlie/ Re-operation Volume (CFS)	Groundwater Storage Volume (TID/MID)	Enlarged Don Pedro Reservoir	Local Ag - to - Urban Water Transfers	Calif. Aqueduct Interlie to SFPUC System	Los Vaqueros Reservoir Enlargement	Shasta Reservoir Enlargement	Other Storage Projects	Regional Ag - to - Urban Water Transfers	Power Replacement	Demand (TAF)	Calaveras Reservoir Pump Volume (CFS)	Calaveras Reservoir Output Capacity (CFS)	Sunol Valley Water Treatment Plant Capacity (MGD)	Groundwater Peak Recharge/ Extraction Rates (MID/TID)		
		1A	1B	1C	1D	1E	1F	1G	1H	2A	2B	2C	2D	3A	3B	3C	3D	3E	3F	1	1	1	1	2		
Environmental Defense	Water Supply Replacement Alternatives																									
	Existing Demand Scenarios																									
	Existing Conditions Base	360	300		465	97		yes		0	0									290	0	143	160	0		
	Surface Storage Replacement	0	300		542	420		yes		407	0									290	200	600	400	0		
	Groundwater Exchange Replacement	0	300		542	97		yes		407	400									290	0	143	400	200		
	Transfer Replacement	0	300		542	97		yes		407	0		yes							290	0	143	400	0		
	Delta Source Transfer Replacement	0	300		542	97		yes		407	0							yes		290	0	143	400	0		
	Future Demand Scenarios																									
	Potential Future Conditions Base, CIP	360	300		542	420					0	0								339	200	600	240	0		
	Transfer Replacement	0	300		542	420				407	0		yes							339	200	600	400	0		
Bay-Delta System Alternatives	Delta Source Transfer Replacement	0	300		542	420				407	0							yes		339	200	600	400	0		
	Groundwater Exchange Replacement	0	300		542	420				407	400									339	200	600	400	200		
	Groundwater Exchange & Transfer Replacements	0	300		542	420				407	400		yes							339	200	600	400	200		
	Don Pedro Interlie & Hetch Hetchy Run-of-River Diversions	0	300		542	97				407	0									339	0	143	400	0		
	Constituents of concern (data)	0	300		542	97				0	0									339	0	143	400	0		
	Existing Demand Scenarios																									
	Existing Conditions Base	360	300		465	97		yes												290	0	143	400			
	CA Aqueduct Interlie	0	300		465	97		yes							yes					290	0	143	400			
	Future Demand Scenarios																									
	Potential Future Conditions Base, CIP	360	300		542	97														339	0	143	400			
UC Davis	CA Aqueduct Interlie, Intermediate Calaveras Expansion	0	300		542	260								yes						339	200	200	400			
	CA Aqueduct Interlie, Full Calaveras Expansion	0	300		542	260				542	260			yes						339	200	200	400			
	CA Aqueduct Interlie	0	300		542	97								yes						339	0	143	400			
	Base	360			465	91														238						
	2020 Level Demand Scenarios																									
	O'Shaughnessy, with filtration avoidance	360			465	91														238						
	O'Shaughnessy, without filtration avoidance	360			465	91														238						
	New Don Pedro Interlie, no O'Shaughnessy, w/o filtration avoidance	0			465	91				yes										238						
	2100 Level Demand Scenarios																									
	O'Shaughnessy w/o filtration avoidance	360			465	91														259						
New Don Pedro Interlie, no O'Shaughnessy, w/o filtration avoidance	0			465	91					yes									259							
Climate Change (O'Shaughnessy, w/o filtration avoidance)																										
Climate Change (no O'Shaughnessy, w/o filtration avoidance)										yes																

Note. Values in this table are modeling assumptions used by ED and UCD. Modeling assumptions were not reviewed for accuracy or acceptability by stakeholders, agencies and the public.
 yes = included in the options, but not quantifiable

ED developed and used its own computer simulation model, TREWSSIM (Tuolumne River Equivalent Water Supply Simulation Model), to analyze the operations of San Francisco Public Utilities Commission (SFPUC), Modesto Irrigation District (MID), and Turlock Irrigation District (TID), using both current and projected 2030 demand levels. These operations are reflected in several Water Supply Replacement Alternatives shown in Table F-1. The model is based on DWR's CalSim II model and its main purpose is to evaluate replacement of the water supply lost by removing O'Shaughnessy Dam. Assumptions in the model include the completion of the SFPUC's Water System Improvement Program, including construction of a fourth San Joaquin Pipeline, expansion of Calaveras Reservoir to 420,000 acre-feet (af), and expansion of the Sunol Valley Water Treatment Plant to 240 millions of gallons per day (mgd). In addition, each replacement alternative in ED's report also included a further expansion of water treatment facilities to 400 mgd.

In addition to the water supply replacement alternatives modeled using TREWSSIM, ED also used CalSim II results to model several Bay-Delta System Alternatives, also shown in Table F-1. These alternatives simulate the delivery of Tuolumne River water to the SFPUC service area via the California Aqueduct and are based on input from TREWSSIM for operation of the Tuolumne River system above New Don Pedro Reservoir.

ED's most comprehensive water supply replacement alternative modeled under future conditions includes the expansion of Calaveras Reservoir to 420,000 af, an intertie between Don Pedro Reservoir and the Hetch Hetchy water system, a groundwater exchange program (both in the San Francisco Bay Area as well as along the lower Tuolumne and San Joaquin rivers,) and water transfers during dry years. These components primarily provide water supply replacement benefits with some power replacement as well.

While the state did not conduct any modeling analyses or work related to the development of alternatives, it did estimate the potential costs of restoring Hetch Hetchy Valley patterned after the most comprehensive water supply and power replacement alternative modeled by ED, as follows.

- Environmental Defense modeled alternative chosen as a basis for the state's cost estimate includes:
 - ♦ Expanded Calaveras Reservoir to 420 thousand acre-feet (taf) (an additional 323 taf)
 - ♦ 200 cubic feet per second (cfs) peak groundwater extraction capacity (400 taf storage volume)
 - ♦ 407 cfs Don Pedro Intertie
 - ♦ 56 taf maximum annual dry year water transfers
 - ♦ Future annual demand of 339 taf (up from existing 290 taf)
- Water management components assumed in state cost estimate include:
 - ♦ 250-450 taf new surface storage
 - ♦ 200-300 cfs peak groundwater extraction capacity (400 taf storage volume)
 - ♦ 400 cfs Don Pedro Intertie
 - ♦ 56 taf maximum annual dry year water transfers
 - ♦ 5-20 taf increased water use efficiency

The state chose this mix of facilities upon which to pattern its cost estimate because it provides a diverse mix of potential benefits. None of the existing studies attempted to define the actual or

potential benefits of O'Shaughnessy Dam and Hetch Hetchy Reservoir. The state team suspects that a one-for-one replacement of Hetch Hetchy water supplies would not be adequate to support restoration of the valley.

While the state estimate makes broad assumptions on a mix of facilities that may be required, it includes the same types of water supply replacement components as proposed by ED, along with increased water use efficiency and additional power replacement components. This combination of water supply and power replacement components was chosen because it has the potential to meet the broad objectives likely to be required in a thoroughly developed study on the restoration of Hetch Hetchy Valley. These broad objectives may include environmental mitigation and enhancement, improved recreation, and replacement of power supply, not only water supply replacement. The state's cost estimate also includes costs for dam removal, valley restoration, and public use. Given the uncertainty involved, a cost estimate range was used because the exact location, facility size, and operational parameters are unknown at this time. The facility mix selected and the cost range presented also takes into account the additional environmental protection and risk mitigation for California water management that may be required to implement these projects.

Results of Existing Modeling Studies

The results of past modeling work performed for various Hetch Hetchy water supply replacement alternatives or scenarios were reviewed to evaluate the overall impact on the Tuolumne River system (including TID, MID and the SFPUC system) and the Bay-Delta system (including SWP/CVP deliveries to SFPUC and system-wide carryover storage). The modeled alternatives had distinguishing characteristics that made each one unique as compared to the others. For example, some alternatives focused on surface storage, while others focused on groundwater storage or transfers. The review of modeling results focused on changes in selected flow, storage and delivery parameters as a result of new or modified water supply sources and re-operations of the SFPUC system. As mentioned before, well-defined objectives and performance criteria have not been developed for these studies. Without knowing the objectives or measuring the relative performance of various alternatives under the existing studies, the following results were selected for presentation and are shown in Figure F-1:

- Variations in carryover storage in the Upper Tuolumne River Basin, with and without O'Shaughnessy Dam
- Variations in inflow to New Don Pedro Reservoir
- Variations in New Don Pedro Reservoir carryover storage
- Variations in groundwater replacement supply to TID and MID
- Additional supplies from the State Water Project, California Aqueduct, and the Central Valley Project's Delta-Mendota Canal Interties to the SFPUC System under the Bay-Delta System proposals
- Variations in the SFPUC carryover storage in local reservoirs
- Variations in total deliveries to the SFPUC service area

The results presented in Figure F-1 reflect the alternatives modeled by ED for scenarios with and without O'Shaughnessy Dam in place. The vertical bars in this figure represent the range of values modeled by ED and present a "sense of scale" showing the range of variations and not the absolute value of changes in the key characteristics. Both dry and average annual variations in selected flow, storage, and delivery parameters are shown to reflect the full range of possible values.

Water Management

Figure 10 is a map of the San Joaquin Hills Water Management System, showing various water storage and distribution facilities. The map includes the following components:

- Map:** A detailed map of the San Joaquin Hills area, showing the San Joaquin River, San Joaquin Hills, and surrounding infrastructure. Key locations include San Francisco, San Jose, and the San Joaquin Hills Water Management System. The map shows the San Joaquin Hills Water Management System, including the San Joaquin Hills Water Treatment Plant, San Joaquin Hills Water Storage, and San Joaquin Hills Water Distribution System. The map also shows the San Joaquin Hills Water Management System, including the San Joaquin Hills Water Treatment Plant, San Joaquin Hills Water Storage, and San Joaquin Hills Water Distribution System.
- Legend:** A legend in the bottom right corner identifies the symbols used on the map:
 - Bay-Delta System (water and power options)
 - Lower Tuolumne System (including MIDTID)
 - Upper Tuolumne System (including SFPUC system)
- Bar Charts:** Seven bar charts are positioned around the map, each showing the range of values for a specific facility or system. The charts are titled as follows:
 - SFPUC Deliveries (201 per year)
 - SFPUC Deliveries to SFPUC (201 per year)
 - SFPUC Local System (201 per year)
 - WQTC Deliveries to SFPUC (201 per year)
 - San Joaquin Hills (201 per year)
 - San Joaquin Hills (201 per year)
 - San Joaquin Hills (201 per year)
- Facilities:** The map includes several key facilities, including:
 - San Joaquin Hills Water Treatment Plant
 - San Joaquin Hills Water Storage
 - San Joaquin Hills Water Distribution System
 - San Joaquin Hills Water Management System
 - San Joaquin Hills Water Treatment Plant
 - San Joaquin Hills Water Storage
 - San Joaquin Hills Water Distribution System
 - San Joaquin Hills Water Management System

The models used, modeling assumptions made, and model limitations in modeling the Bay-Delta System and specifically the Hetch Hetchy facilities are described below.

Examples of system modeling assumptions include: water quality standards, State Water Project (SWP) Banks Pumping Plant and Central Valley Project (CVP) Tracy Pumping Plant capacities, the Environmental Water Account (EWA), water transfers, the Vernalis Adaptive Management Program (VAMP), etc. Some specific Hetch Hetchy assumptions include the use of or modifications to existing facilities, new future facilities, TID/MID water allocations, SFPUC demands, system operations, etc. Assumptions for modeling various scenarios for both the Hetch Hetchy System and the Bay-Delta System are given in Table F-2.

Table F-2. Hetch Hetchy Restoration Study: General Characteristics and Model Assumptions for Past Operation Studies

	U.C. Davis	Environmental Defense
MODEL CHARACTERISTICS		
Model Name/date Technique	CALVIN 2001	TREWSIM 2004
Simulation or Optimization	Optimization	Simulation (based on CALSIM)
Foresight		
Use of foresight	Yes	No
Flow sequence		
Historic flow sequence or forecasted flow	Forecasted flow	Historic flow
Water Allocation Basis		
Economic or water rights	Economic	Water rights
Period of Simulation	1922-1993 (72 years)	1922-1994 (73 years)
Level of Development	2020 Level based on DWR B160-98, 2100 (Landis and Riley, 2002 cited in Pulida-Velasquez and Jenkins, 2002)	2020 Level Based on DWR B160-98
Institutional Constraint	No	Yes
BAY-DELTA SYSTEM ASSUMPTIONS		
Water Quality Standards	1995 Water Quality Control Plan, present and assumed for future (Based on DWRSIM September 1997 Study 514)	1995 Water Quality Control Plan, present and assumed for future.
SWP Banks Pumping Plant	Based on DWRSIM September 1997 Study 514	6,680 cfs
CVP Tracy Pumping Plant	Based on DWRSIM September 1997 Study 514	4,200 cfs plus diversions upstreams of DMC constriction
Trinity River Diversions	Based on DWRSIM September 1997 Study 514	Interim Minimum Flow below Lewiston Dam (369-453 TAF/Yr)
CVPIA Requirements	Pre-CVPIA, no CVPIA actions	CVPIA actions included
American River Diversions	SWRCB D-893	SWRCB D-893 and USFWS discretionary use of CVPIA 3406(b)(2)
EWA	Pre-EWA, no EWA actions	EWA actions included in baseline
Regulatory flows	Environmental flows in the Sacramento-San Joaquin Delta system are simplified. Flows for river reaches are not modeled explicitly but taken from DWRSIM September 1997 Study 514.	"OCAP 2001 with EWA" study used in baseline. Study assumes compliance with regulatory/environmental objectives.
Vernalis Adaptive Management Program	VAMP actions not included	VAMP actions included
Water Transfers	Scarcity driven transfers allocated economically	No water transfers
HETCH HETCHY RELATED ASSUMPTIONS AND FACILITIES		
Existing Facilities	O'Shaughnessy, Hetch Hetchy aqueduct, New Don Pedro, Cherry and Eleanor reservoirs, SWP and CVP systems	O'Shaughnessy, Hetch Hetchy aqueduct, New Don Pedro, Cherry and Eleanor reservoirs, SWP and CVP systems
Alternatives Investigated	<p>2020 Level</p> <ul style="list-style-type: none"> * O'Shaughnessy with filtration avoidance * O'Shaughnessy without filtration avoidance * New Don Pedro Intertie without O'Shaughnessy, without filtration avoidance <p>2100 Level</p> <ul style="list-style-type: none"> * O'Shaughnessy, Hetch Hetchy aqueduct, New Don Pedro, Cherry and Eleanor reservoirs, SWP and CVP systems * O'Shaughnessy without filtration avoidance * New Don Pedro Intertie without O'Shaughnessy, without filtration avoidance * Climate Change, O'Shaughnessy without filtration avoidance * Climate Change, no O'Shaughnessy, without filtration avoidance 	<p>Water Supply Replacement Existing Demand (2004)</p> <ul style="list-style-type: none"> * Base with O'Shaughnessy * Without O'Shaughnessy, Surface storage replacement, Groundwater Exchange, Transfer replacement <p>Future Demand (2030)</p> <ul style="list-style-type: none"> * CIP with O'Shaughnessy * Without O'Shaughnessy, Transfer replacement, Groundwater Exchange, Groundwater and Transfer * Don Pedro Intertie and Hetch Hetchy Run-of-River diversion * Cherry/Eleanor Intertie and Hetch Hetchy Run-of-River diversion <p>Bay-Delta System Alternatives</p> <ul style="list-style-type: none"> * Cal Aqueduct Intertie with and without expanded S.J. Pipeline * Cal Aqueduct Intertie with intermediate and full Calaveras Expansion
Assumed Future Facilities	Unlimited desalination facilities, Urban wastewater recycling, Lower Cherry Creek, San Joaquin Pipeline, Don Pedro Intertie	Expanded Calaveras Reservoir, San Joaquin Pipeline, SWP/CVP aqueduct Intertie, Don Pedro Intertie, Cherry Lake Intertie
Demands		
TID/MID Bay Area	Water Rights	Water Rights
City of San Francisco and others	(TAF)	(TAF)
	2020 2100	Current 2030
	SFPUC 238 259	SFPUC 290 339
	SCV 656 927	
	CVPM(urban) 545 1773	
	CVPM(ag) 5259 4509	
Operations		
Tuolumne River		
Minimum Flow at Lagrange Bridge	SANJASM	FERC 2299-024, 1995 (Settlement Agreement)
Flow Objective for Power	FERC 2299-024 Settlement Agreement	FERC 2299-024 Settlement Agreement
Change in Power Operations	Kirkwood Plant Eliminated, Holm and Moccasin reduced output	Thermal Plants, Cherry Intertie
Flow objective for Fisheries	FERC 2299-024, 1995 (Settlement Agreement)	FERC 2299-024, 1995 (Settlement Agreement)
Flood Control	No	30 TAF flood space in Don Pedro
TID/MID Water Allocations	Water Rights	Water Rights
CVP Water Users		
Settlement and Exchange	CALVIN Economic Allocations	100% (75% in Critical years)
Refuges	Level 2 Refuge Water Assumed (pre-CVPIA), except 2100 level demand where some Level 4 assumed, (UCD Study, page 20)	100% (75% in Critical years)
Agriculture	CALVIN Economic Allocations	100% - 0% based on supply (Allocations are reduced due to D1640 and 3406(b)(2) allocations related export restrictions)
Municipal & Industrial	CALVIN Economic Allocations	SFPUC California aqueduct link given first priority for South of Delta Deliveries
SWP Water Users		
South of Delta	CALVIN Economic Allocations	Based on supply
City of San Francisco and Other Water Allocations	CALVIN Economic Allocations	SFPUC local storage equals combined capacities for Calaveras, San Antonio, San Andreas, Crystal Springs and Pilarcitos reservoirs.

The development of modeling assumptions is typically based on a thorough understanding of the existing system and may involve a projection of potential future conditions; however, due to institutional constraints, physical limitations, and future demographic changes, uncertainties in these assumptions are inherent. The primary area of uncertainty related to water management assumptions for Hetch Hetchy water and power replacement is future Bay-Delta system and

SFPUC system water demand influenced by, among other things, population growth, future land use changes, and future environmental water requirements. Uncertainties in modeling assumptions often result in modeling limitations. Specific limitations of past modeling evaluations by U.C. Davis and ED include the following:

- Modeling gave first priority to meeting Bay Area demand and fulfilled south-of-the-Delta SWP and CVP contractor demands only after all Bay Area demands were met. Institutional constraints and water rights may not allow this.
- Flooding is a serious concern for downstream communities in the Tuolumne Basin. An economic-based model algorithm does not provide for any flood control space in lieu of lost flood control space in Hetch Hetchy Reservoir.
- As decisions for operational actions are based on economics, the reservoir's lower bounds are not maintained. Dead pool was assumed as the minimum storage which results in considerable environmental impact and water supply risk during drought periods.
- Groundwater-surface water transfers are based on assumptions that a perfect foresight groundwater management will result in additional availability of surface water supplies. Current groundwater overdraft in the San Joaquin Valley casts doubt on such perfect foresight.
- For the purpose of modeling, it was assumed that in the future, the agricultural sector will accept reduced water supplies and agree to transfer agricultural water allocations to urban use. The National Economic Development (NED) impacts of these changes are unknown.

Future Modeling Assessments

Future modeling assessments should take a broad look at not only the flow, storage, and delivery parameters, but additional parameters that should be evaluated. Specific performance objectives should be established and predictive performance measures and other indicators should be considered when evaluating system-wide performance of various restoration proposals. The following points outline some potential future modeling needs required to begin evaluating system-wide performance:

- System integration of various, recognized, project components is required to determine the acceptable size of each component for development of an overall project plan for water supply and power replacement.
- Optimization studies will help in formulating a plan to meet water supply and power objectives. An acceptable combination of modifications in the upper and lower Tuolumne basin, including the SFPUC system, needs to be developed.
- System modeling in combination with resource evaluation models is needed for impact evaluations and to aid in decisions related to viability of the restoration proposal.
- Current institutional constraints and any potential changes to them need to be thoroughly considered in any project plan. Institutional constraints, when applied, may limit the use of certain components in the formulation of alternatives. For example, water rights restrictions may limit the transfer of groundwater supplies to surface water, or the use of Don Pedro Reservoir by SFPUC may impact TID and MID water interests.

Reference

Jenkins, et al. 2001. *Improving California Water Management: Optimizing Value And Flexibility*. Avail. at <http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/Report2/>

APPENDIX G. SUPPORT FOR COST ESTIMATE

Total costs of restoring Hetch Hetchy Valley include capital costs for water and power replacement components, dam removal or modification, Hetch Hetchy Valley restoration, development and implementation of recreation plans for the valley, environmental protection, mitigation, and land acquisition costs. The capital costs also include contingencies, engineering design, permitting, construction, legal and project administration costs. Annual costs include operation and maintenance, monitoring, reoccurring annual purchases, and other annual costs. Initial planning studies required for the project are not included in the capital cost.

Overview of State's Cost Estimate

Effect of Future Water Management Strategies on Cost

In the future, water management challenges will become even more complex as the population increases, demand patterns change, environmental needs are better understood, and global climate change is experienced. Policy makers and the public need more detailed quantitative information about the costs, benefits, and tradeoffs associated with different water management strategies. Future water management initiatives are likely to incorporate two main themes to 1) promote and practice integrated regional water management, and 2) maintain and improve statewide water management systems.

Project costs will reflect how well these two initiatives complement efforts to fill water supply and power replacement gaps created by removing Hetch Hetchy Reservoir. Integrated regional water management within the Tuolumne River watershed and the San Francisco Public Utilities Commission (SFPUC) service area can meet some of the future challenges. The unfulfilled need could be met by statewide management systems such as links to the Bay-Delta System or other measures like groundwater supplies, transfers, water conservation, recycling and desalination. In previous studies, Environmental Defense (ED) and Restore Hetch Hetchy (RHH) have come up with project costs that reflect both of these strategies. In preparing this summary, the Department of Water Resources (DWR) used its experience in planning, design, and construction to review existing cost estimates. In addition, DWR updated and filled in gaps to come up with an overall project cost.

Planning Study Costs

This estimate represents the expected cost of several years of normal planning, feasibility, and environmental studies leading to permits and prior to detailed engineering design and construction. These costs may require allowances for regional environmental and economic benefits or national surveys. Studies would consider alternative approaches to water and power management, dam removal, and valley restoration. Major deliverables from this process would be a plan formulation and project feasibility report.

Water Supply Replacement Costs

Environmental Defense: ED water supply estimates are based on construction of a Don Pedro-Hetch Hetchy intertie, the rebuilding (and possible expansion) of Calaveras Reservoir, development of a groundwater bank, and the purchase of water from willing sellers in critically dry years. ED's estimate also includes a 240 mgd expansion of the Sunol treatment plant. ED provided cost estimates for the current SFPUC delivery objective and for a projected 2030 SFPUC delivery objective. ED used a discount rate of 5% to convert cash flows to present values. To cover the

range of uncertainty, ED used -30% and +50% factors to arrive at a range of \$500 million to \$1.65 billion. Further details of the ED estimate are given in Table G-1 in the cost backup section below.

Restore Hetch Hetchy: RHH reviewed the SFPUC Capital Improvements Program and developed cost estimates considering the needs of San Francisco's water customers. A preferred water alternative was developed which included water conservation and efficiency programs, a pumped diversion from the Tuolumne River, use of Cherry Lake and Lake Eleanor storage with re-operation, an enlarged Don Pedro Reservoir, an additional San Joaquin pipeline, and an expanded Calaveras Reservoir of 420 thousand acre-feet (taf). More detail of the RHH estimate is given in Appendix A. RHH believed that filtration of the water supply should be implemented regardless of the fate of O'Shaughnessy Dam and therefore did not include filtration as a cost associated with removal of the dam.

Power Related Costs

Department of Energy (DOE): DOE's 1988 review of the U.S. Bureau of Reclamation's (Reclamation) report concludes that removal of O'Shaughnessy Dam would result in net loss of 150 megawatts (MW) of capacity and approximately 900 gigawatt hours (GWh) of energy annually. They commented that many of the water replacement concepts are net energy consumers due to pumping requirements. They also forecasted that new generation capacity would likely be required after year 2000. In 1988, DOE estimated the levelized annual cost of this replacement capacity and energy at \$109 million over an assumed 20-year life (present value of about \$1.5 billion using a 6% discount rate.)

Restore Hetch Hetchy: Their "Feasibility Report 2005" presents a preferred recommendation of 1) constructing a new "run-of-river" intake/diversion capability for Canyon Tunnel that would retain some generation capability at Kirkwood and 2) constructing a pumped connection from Holm Powerhouse discharge over to Mountain Tunnel. Water pumped from Holm to Early Intake Reservoir would supplement dry period, run-of-river diversions into Mountain Tunnel and reduce lost generation at Moccasin Powerhouse. RHH claims the increased flow (and resultant generation) through Moccasin Powerhouse more than makes up for the pumping costs.

The RHH report claims a net energy loss during a median water year of 550 GWh, after implementation of the two physical components described above (a new diversion into Canyon Tunnel and a pumped connection between Holm Powerhouse and Canyon Tunnel), with an estimated energy replacement cost from "market sources" of about \$30 million/year. RHH recommends this market replacement be made up of efficiency programs and renewable resources, rather than construction of new fossil generation, but goes on to admit that the cheapest replacement would likely be new fossil generation and uses that for estimating costs. RHH estimates the cost of replacing 550 GWh from new fossil generation as 14% of the output (energy) of a new 500 MW combined cycle plant at \$98 million. It may be more accurate to say it represents about 20% of the capacity of a new plant, which increases the capital cost to \$143 million. The production costs of actually producing the energy could be an additional \$20 million/year. For purposes of this report, it was assumed that replacing the lost energy from renewable sources would further increase costs about 20%.

Table G-1. Restore Hetch Hetchy estimates of power replacement costs (in millions)

RHH power replacement options	Initial	Annual
New diversion facilities for Canyon Tunnel	\$52	
Modifications to Kirkwood Powerhouse	\$14	—
Holm pumped connection to Early Intake Reservoir	\$59	
Fossil replacement (minimum cost)	\$98	\$20
Renewable replacement (assumed 20% higher)	\$118	\$10
The present value of fossil replacement (30 years at 6%) is about \$498 million. The present value of renewable replacement is about \$381 million.		

University of California, Davis (UCD): Null's 2003 thesis reports an average annual loss of 457 GWh. Using wholesale energy prices varying between \$18/megawatt hour (MWh) and \$30/MWh, Null estimates an annual replacement cost to the SFPUC system of \$12 million. This estimate is probably low, given that 2005 energy prices are 2 and 3 times greater than the 2003 prices. This is for energy alone, without including any capacity or capital costs.

Environmental Defense: Their 2004 report, *Paradise Regained*, estimates a minimum of 339 GWh needs to be replaced at an annual cost of \$19 million/year (using a levelized cost of \$55/MWh.) This assumes construction of a pumped connection between Holm and Mountain Tunnel. Without this pumped connection to recover some of the energy, replacement numbers double to 690 GWh at an annual cost of \$38 million/year. Present value of a 30-year series at 6% for these two replacements is \$262 million and \$523 million, respectively.

Conclusion

Energy replacement costs vary from a low of \$232 million to over \$1 billion with a “core” of estimates in the range of \$320 to \$570 million. Treating the high and low as outliers, using the core range of values, and applying a 30% markup to cover uncertainties in estimating these costs results in a range of \$420 to \$740 million.

Dam Removal Costs

Restore Hetch Hetchy: RHH assumed a five-year construction period for dam removal. Approximately 600,000 cubic yards of material would be removed from the dam site by milling down to aggregate base rock and transporting it by conveyor belt to Camp Mather. Hauling the debris from Camp Mather to a quarry or dump west of Sonora would require approximately 26,000 transfer loads (200 truck trips per day) to accomplish this off-haul in one season. Area roads will need improvement before starting deconstruction. The first three years of construction would involve road improvements, conveyor belt start-up, reservoir lowering, and Tuolumne River diversion tunnel construction. Removal of electrical equipment would occur in year 2, removal of hydraulics would occur in years 3 and 4, and concrete demolition would be completed in year 5. RHH estimates dam removal costs at \$144 million.

Valley Restoration Costs

Restore Hetch Hetchy: Valley restoration would start with aggressive replanting of native plants as soon as the soil dried sufficiently. Follow-up activities would be Tuolumne River stream restoration and landscape restoration around valley slopes. The RHH estimate does not specify any mitigation cost for the great gray owl, a California-listed endangered species. The total estimate for valley restoration, engineering design, 10% contingencies, and three years of maintenance is \$28 million. RHH estimates the cost of maintaining and monitoring the vegetation and other

restoration work at \$300,000 to \$600,000 per year until approximately the tenth year, after which RHH expects maintenance costs to decline.

Public Use Plan Development

Restore Hetch Hetchy: There are no estimates of cost. However, the RHH report refers to human use of the valley after the dam is gone and the various forms it could take. RHH expects that the National Park Service, with broad public input, will ultimately be responsible for determining an access and recreation plan for the valley.

Public Use Development Costs

A very rough estimate for developing camping-related recreation opportunity was made by the state. That total of \$33 million does not include a visitor center, building(s) for overnight facilities, food establishments, etc.

Miscellaneous Costs

Miscellaneous costs include environmental protection, permitting and mitigation, contingencies, engineering design, construction, and administration costs. RHH and ED included partial environmental protection costs; however, there is no mention of mitigation costs. ED contingencies for various cost estimate components varied from 10% to 15% of the total project cost and engineering design, legal and administration was 12.5%. RHH used 10% of the project cost for design, engineering and permitting, 10% for construction administration, and 10% for contingencies.

DWR Cost Estimate Summary

DWR used recent experience on other large projects to estimate a range of probable costs of implementing a restored Hetch Hetchy Valley. In some instances where DWR could not find a comparable way of determining cost, RHH or ED estimates were used. A summary of DWR costs is given in Table G-2, followed by information on the specific basis for costs.

Following are some highlights of the DWR cost estimate:

- An average cost per unit of surface storage was developed from five surface storage programs currently being studied jointly by DWR and Reclamation as part of the CALFED Integrated Storage Investigations Program.
- Groundwater storage and extraction costs are based on Proposition 13 projects funded by DWR in the last four years.
- Conveyance costs, such as interties to the SFPUC system, used typical costs developed by DWR's Division of Engineering for the State Water Project's South Bay Aqueduct expansion.
- Costs for intertie structures, such as reservoir intake towers, are based on the State Water Project's San Bernardino Intake Structure experience.
- Pumping costs (including pumps, pipelines, tunnels, motors, valves and other mechanical work) were predicted using State Water Project (SWP) cost experience with the Coastal Aqueduct, East Branch Extension pump stations, and Mojave Siphon Power Plant.
- Power transmission line costs are based on a quotation from SMUD.

- Dam removal methods and costs were compared to other dam removal projects in USA: Elwha and Glines Canyon Dams on the Elwha River in Olympia National Park, Washington; Matilija Dam on Ventura River in California; and San Clemente Arch Dam on the Carmel River in California.
- Valley Restoration and Recreation Plan Development costs were provided by the National Park Service and the California Department of Parks and Recreation.
- Environmental documentation, permitting, and mitigation costs are assumed to be a typical 30% allowance that is comparable to other DWR projects for stream restoration, fish and wildlife mitigation, and ecological projects.
- In the last two years, DWR has experienced significant escalation in construction costs. Based on recent construction, 30% is used for engineering design, construction and project administration.

Additional notes on assumptions or basis for DWR costs follow Table G-2.

Plan Formulation: Background on Planning Study Costs

A cost estimate to conduct future Hetch Hetchy valley restoration planning studies was developed by comparing costs of three recent large-scale planning efforts: the CALFED Bay-Delta Program Programmatic EIR/EIS, the Central Valley Project Improvement Act (CVPIA) Programmatic EIS, and the Federal Energy Regulatory Commission (FERC) Oroville Facilities Relicensing. Additional information was taken from the cost estimate for the Plan Formulation Study described in Reclamation's report *Hetch Hetchy: Water and Power Replacement Concepts, 1988*.

CALFED Bay-Delta Program Programmatic EIR/EIS

The cost for initial planning efforts and environmental documents for the CALFED Bay-Delta Program Programmatic EIR/EIS was \$35 million. This includes the cost of all pre-Stage 1 efforts (1994 to 2000) up to signing of the Record of Decision (ROD), but excludes ecosystem restoration costs.

Central Valley Project Improvement Act Programmatic EIS

The cost for initial planning efforts and environmental documents for the CVPIA Programmatic EIS (1992 to 2000) was \$29 million.

FERC Oroville Facilities Relicensing

The FERC Oroville Facilities Relicensing project has cost \$65 million to date, including the Alternative Licensing Process and significant outreach effort. Another \$10 million is expected to be needed to complete the six-year process, for a total of \$75 million.

Reclamation's 1988 Hetch Hetchy Restoration Plan Formulation Study Costs

The 1988 Reclamation report discussed the required elements for a feasibility study to examine the benefits, impacts and costs of restoring Hetch Hetchy Valley. Plan formulation studies were estimated at that time to require \$3 to \$5 million and six years to complete, exclusive of any work on restoration plans and uses for the valley required by the National Park Service.

State Estimate to Complete Federal Plan Formulation Report

This planning effort could take up to 10 years of normal planning, feasibility, and environmental studies, including programmatic documents. The state estimates \$65 million might be needed to complete a federal Plan Formulation Report. Table G-3 summarizes recent large-scale planning efforts and the state estimate.

Table G-2. A Cost Estimate for Hetch Hetchy Restoration
(in millions of 2005 dollars)¹

PLANNING COSTS	
Plan Formulation (site-specific engineering, environmental documentation, permitting, and mitigation are not included in this planning level work, see F and G below)	
Level 1: Complete concept level studies	7
Level 2: Appraisal level studies	13
Level 3: Feasibility level studies	32
Level 4: Detailed studies and programmatic documents (but <u>not</u> including final design, permits, and other site-specific work in Items F and G below)	13
Grand Total of Planning Costs	\$65 +
IMPLEMENTATION COSTS	
A Implement Water Replacement Components ²	\$1,144-\$4,305
1 Construct new water supply facilities	
A 250,000 to 450,000 af new surface storage ³	163-1,460
B 200 to 300 cfs groundwater banking program ³	150-230
C Intertie (Don Pedro or SWP)	53-234
2 Acquire dry-year supply transfer water	22-86
3 Expand water treatment facilities	310-515
4 Increase water use efficiency (5,000 to 20,000 af) ³	46-210
5 Present worth of increased annual O&M costs	400-1,570
B Implement Power Replacement Components ²	\$560-\$820
1 Construct new facilities	
A new 1,500 cfs Canyon Tunnel intake	70
B modifications to Kirkwood for reduced "head"	30
C 730 cfs pumped connection from Holm to Mountain Tunnel	40
2 Purchase replacement capacity and energy	420-680
C Modify or Remove Dam	\$250-\$915
1 Mobilization and set-up (crusher, conveyor, roads, etc.)	39-65
2 Deconstruct dam	178-810
3 Demobilization and clean-up	33-40
D Restore Valley	\$32-\$53
1 Refill quarry excavations and recontour ground surface	1
2 Native species revegetation and stream restoration	30-50
3 Maintenance and monitoring (adaptive management)	1-2
E Implement Visitor Use Plan for Valley	\$10-\$91
Subtotal of Direct Costs	\$1,996-\$6,184
F Site-Specific Environmental Documents, Permits, and Mitigation (20-30%)	\$390-\$1,790
G Engineering, Legal, and Administration (30%)	\$610-\$1,850
Grand Total of Implementation Costs	\$2,996-\$9,824
TOTAL PROJECT COST = \$3,061 to \$9,889	

- NOTES**
- 1 Estimates are based on similar project experience and include 30% markup for uncertainty in estimating costs (see specific estimate notes).
 - 2 Resource mix based on alternative modeled by Environmental Defense includes an additional 323 taf storage in Calaveras Reservoir, a 200 cfs groundwater extraction program, a 407 cfs Don Pedro Intertie, 56 taf maximum annual dry year water transfers, and increased future demands. Power replacement facilities were based on other existing Hetch Hetchy water and power replacement studies. This combination of water supply and power replacement components was chosen because it has the potential to meet the broad objectives likely to be required in a thoroughly developed study on the restoration of Hetch Hetchy Valley.
 - 3 Given the uncertainty involved, a cost estimate range was used in the state estimate because the location, facility size, and operational parameters are unknown at this time. The facility mix selected and the cost range presented also accounts for additional environmental protection and risk mitigation for California water management that may be required to implement these projects.

Table G-3. State estimate to complete future planning studies

Planning Effort	Study Cost
CALFED Bay-Delta Program Programmatic EIR/EIS	\$35 million
Central Valley Project Improvement Act Programmatic EIS	\$29 million
FERC Oroville Facilities Relicensing	\$75 million
Reclamation's 1988 Hetch Hetchy Restoration Plan Formulation Study Costs	\$3-5 million
Estimate to complete federal plan formulation report	\$50 million
30% markup to cover uncertainty in estimating costs	\$15 million
State estimate to complete federal plan formulation report	\$65 million

A1a. Cost Estimate for Surface Storage

To be consistent with Environmental Defense's modeling that the state's cost estimate is patterned on, new surface storage was selected as one of the water supply replacement components. New surface storage was chosen because, among other components, it has the potential to help meet the broad objectives likely to be required in a thoroughly developed study on the restoration of Hetch Hetchy Valley.

This estimate for constructing new surface storage was developed by comparing the most recent cost estimates for the five surface storage projects being studied by DWR and Reclamation as part of the CALFED Integrated Storage Investigations. Some of these cost estimates are more refined than others because they are in different stages of the planning process. The unit costs shown in the table were developed by dividing the current estimate of project capital cost by the total storage capacity to get a cost per acre-foot of storage capacity for each project. Average unit costs range from about \$500 per acre-foot for north of Delta alternatives like expanding Shasta Lake and constructing Sites Reservoir, up to about \$2,500 per acre-foot for developing In-Delta storage and expanding Los Vaqueros Reservoir.

Environmental Defense assumed a 323 taf expansion of Calaveras Reservoir in its modeling studies, so a minimum volume of 250,000 acre-feet (af) of new surface storage was selected for this estimate. This amount does not completely replace the loss of Hetch Hetchy (360,000 af), but might be sufficient when combined with other components. Using prices from the paragraph above, the cost of 250 taf would range from \$125 to \$625 million. Given the uncertainty involved, a storage volume range was used in the state's estimate because the exact location, facility size, and operational parameters are unknown at this time. The storage volume range selected also accounts for additional environmental protection and risk mitigation for California water management that may be required to implement a surface storage project. To account for these uncertainties, as much as 450,000 af of new surface storage may be needed for the upper end of the range. In this case, the cost would range from \$225 to \$1,125 million.

Using a bookend approach, the cost of new surface storage is estimated to range from \$125 to \$1,125 million. After adding a 30% markup for estimate uncertainty, the range for new storage is \$163 to \$1,460 million.

Table G-4. State estimate for constructing new surface storage

Surface Storage Project	Storage Capacity⁽¹⁾ (1,000 acre-feet)	Capital Cost Estimates⁽²⁾ (millions)	Unit Cost⁽³⁾ (\$ per acre-foot of storage capacity)
Shasta Lake Water Resources Investigation ⁽⁴⁾	300-635 (6.5 ft.-18.5 ft. raise)	\$160-\$290	\$530-\$460
North-of-Delta Offstream Storage ⁽⁵⁾ (Sites Reservoir Alternative)	1,800	\$650-\$1,150	\$360-\$640
In-Delta Storage ⁽⁶⁾	217	\$500-\$520	\$2,350-\$2,390
Los Vaqueros Reservoir Expansion ⁽⁷⁾	200-400 (Range of Expansion)	\$500-\$750	\$2,520-\$1,890
Upper San Joaquin Storage ⁽⁸⁾	340-1,360 (Yokoh Valley and Temperance Flat)	\$300-\$400	\$1,320-\$440
Selected Cost Range	—	—	\$500-\$2,500

(1) The range of storage capacity for Shasta Lake Water Resources Investigation, Los Vaqueros Reservoir Expansion, and Upper San Joaquin River Storage reflects the range of storage locations and options being studied.

(2) Capital costs were derived from the total project cost estimates for each project and do not include site-specific environmental documentation, permitting, mitigation, contingencies, engineering, legal and administration costs or pumping and operations and maintenance costs.

(3) Unit costs were developed by dividing capital costs by storage capacity.

(4) Preliminary cost estimates are from ongoing studies.

(5) Preliminary cost estimates are from ongoing studies.

(6) Preliminary cost estimates are from 2005 Supplemental Studies.

(7) Preliminary cost estimates are from *Draft Planning Report*, May 2003.

(8) Preliminary cost estimates are from *Initial Alternatives Information Report*, June 2005.

A1b. Cost Estimate for Groundwater Storage

Environmental Defense proposed and modeled a groundwater-exchange program to replace the dry-year supply currently provided by Hetch Hetchy Reservoir. This program assumed a recharge and extraction capacity of 200 cubic feet per second (cfs) or 145,000 af per year. The modeling suggested an annual average of 51,000 af of groundwater use in years the groundwater bank is used with a maximum annual use of 119,000 af. Additional conveyance facilities are assumed to allow in-lieu recharge of up to 386 cfs. The program assumes a bank volume of 400,000 af, 400 acres of recharge ponds, 73 new recovery wells, and conveyance and on-farm distribution systems serving roughly 29,100 acres.

Costs for groundwater recharge ponds and extraction wells costs were estimated by comparing five groundwater storage projects proposed in 2001 and 2003 applications for Proposition 13 (Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act) groundwater storage grants. Information on land, conveyance, and distribution systems in the Proposition 13 groundwater storage grant applications was not sufficient to use in this estimate, so estimates for these items were taken directly from the Environmental Defense report.

Table G-5. Costs for recharge ponds and extraction wells, based on Proposition 13 application information

Applicant	Recharge Ponds	Extraction Wells	
		Description	Cost Per Well
North Kern Water Storage District	Using existing ponds	2,400 gpm (or 5.25 cfs); drilling depth of 900 ft.; vertical turbine pumping unit with electric motor driver.	\$288,145
Buttonwillow Improvement District	Using existing ponds	Pumps, motors and Motor Control Center Equip. (60 cfs at 65 ft., 650 HP)	\$81,250
Buena Vista Water Storage District	—	1 large (2,900 gpm at 250 ft.) and 2 medium (2,250 gpm at 150 ft.) extraction wells being installed.	Large: \$316,150 Medium: \$236,100
James Irrigation District	No information provided	Two 500 ft., 100 HP wells to be installed	No cost provided
Arvin Edison Water Storage District	2 recharge ponds constructed on 30 acres for \$514,109 each or \$34,274 per acre.	4 extraction wells (980 ft. deep wells, 1,800 gpm, 400 HP)	\$270,000
Average Cost	\$34,274 per acre		\$277,600 per well

Table G-6. State estimate for constructing new groundwater storage

Proposed Facility	Cost Estimate				Source
	Quantity	Unit	Unit Cost	Total Cost	
Recharge ponds	400	acre	\$34,300	\$13,720,000	Prop. 13
Land	400	acre	\$15,000	\$6,000,000	Schlumberger
Trunk conveyances	29,100	acre	\$1,600	\$46,560,000	Schlumberger
On-farm distribution	29,100	acre	\$1,000	\$29,100,000	Schlumberger
1,500 gpm (3.34 cfs) extraction wells	73	each	\$277,600	\$20,265,000	Prop. 13
Subtotal Cost				\$115,645,000	DWR
30 % markup for estimate uncertainty				\$34,694,000	DWR
Total Cost				\$150,339,000	

Comparable Project

Madera Irrigation District (MID) is requesting Proposition 50 grant funds to implement the Water Supply Enhancement Project (WSEP). This project is similar to that proposed by ED and, although it is only two-thirds the size, it can be used to compare costs of a similar groundwater exchange program. The project would upgrade existing MID conveyances and add additional recharge areas and new recovery wells. Important characteristics of the WSEP are: total storage capacity up to 250,000 af, annual capacity up to 55,000 af/year, and instantaneous capacity of approximately 200 cfs. Conveyance is gravity flow through existing MID canals, the recharge basin area is 1,000 acres, the swale recharge areas are approximately 700 acres, the in-lieu surface water delivery recharge areas are 2,600 acres, and there are up to 49 new recovery wells. The estimated cost of the project, including land, is \$71.2 million (2005 dollars). Extrapolating this cost yields an estimated cost of \$92.6 million.

Suggested Cost Range

Using the Proposition 13 as the basis for the cost for a 200 cfs groundwater banking program, the cost would be about \$116 million. Due to uncertainty in size and performance of this program, the state team assumed both a 50% increase in program size (to 300 cfs) and a 50% increase in costs to account for additional environmental protection and risk mitigation for California water management. In that case, the cost would be about \$174 million. Using a bookend approach, the

cost of new groundwater storage might therefore range from \$116 to \$174 million. After adding a 30% markup for estimate uncertainty, the range for the groundwater storage program is \$150 to \$230 million.

A1c. Cost Estimate for Intertie Facilities

Two different intertie facilities are estimated below. The Don Pedro intertie was chosen initially due to lower cost, but the SWP intertie might be required if replacement water is routed through the Delta. DWR's experience with recent construction projects was used, as noted.

Table G-7. State estimate for intertie facilities

Conveyance Options	DWR Estimate				Comments
	Quantity	Unit ¹	Unit Cost	Total Cost	
A1c. Don Pedro Intertie (Component 2A)					
Intake structure	1	Ls	\$4,000,000	\$4,000,000	Predicated on San Bernardino Intake Structure
Pump station	16,250	HP	\$2,080	\$33,800,000	Predicated on Coastal and East Branch Extension pump stations. Includes: pumps, motors, valves, elec. and mech. work.
Pipeline	2,400	Lf	\$630	\$1,512,000	Used Coastal Branch Reaches 1 and 2, East Branch Extension Reaches 1 and 2
2 million gallon regulating basin	10,700	Cubic yards	\$100	\$1,070,000	Used Environmental Defense est. Haul and amount of crushing and sorting unknown at this time.
Vertical shaft	50	Lf	\$7,500	\$375,000	Predicated on Mojave Siphon P.P.
Subtotal				\$40,757,000	
30% markup for estimate uncertainty				\$12,228,000	30% of subtotal cost
Total cost ¹				\$52,985,000	
A1c. California Aqueduct Intertie to SFPUC System (Component 3A)					
Expanded South Bay Aqueduct (SBA)	1	Ls	\$180,000,000	\$180,000,000	Predicated on SBA Enlargement, includes civil, structural, mechanical, architectural and electrical engineering; contingencies; design and construction engineering; and administration. Includes necessary additional conveyance facilities above and beyond existing.
30% markup for estimate uncertainty				\$54,000,000	30% of subtotal cost
Total cost ²				\$234,000,000	
¹ Ls=lump sum; HP=horsepower; Lf=lineal feet; Cubic yds=cubic yards					
² Total cost may differ from main estimate due to rounding differences					

The range of costs for this component is therefore \$53 to \$234 million.

A2. Cost Estimate for Water Transfer Supplies (Component 2D)

Environmental Defense's model suggested that with an intertie to Don Pedro Reservoir (or via Delta diversions) agricultural to urban water transfers could replace a portion of the SFPUC supply currently provided by Hetch Hetchy Reservoir during dry years. ED's TREWSSIM model simulation of water transfers suggests that, under future conditions, the SFPUC would

occasionally need to purchase a transfer supply of 84 taf. The last 30 years of the 73-year time series model output from this simulation was used to determine a present value cost for this transfer supply.

Several sources of recent water transfers were reviewed to determine a unit cost per acre-foot for water transfer supplies. Since the Environmental Water Account (EWA) program began, the price paid for EWA water was highest in 2001, ranging from \$138 to \$370 per acre-foot south of the Delta and \$75 to \$100 north of the Delta. DWR's EWA spreadsheet model assumes prices upstream of the Delta ranging from \$27 to \$135 per acre-foot and south of the Delta prices ranging from \$10 to \$200.

Reclamation's Water Acquisition Program reports that prices paid have generally been in the range of \$50 to \$150 per acre-foot from water users south of the Delta.

Metropolitan Water District of Southern California recently purchased several one-year water transfer options from the Sacramento Valley (MWDSC 2003; Hirsch 2005). The prices ranged from \$105 to \$125 per acre-foot.

Westlands Water District reports water transfer costs from 2000 through 2004 of \$108 to \$147 per acre-foot.

ED's report used water transfer costs of \$500 per acre-foot for Delta diversions. No background data was given for this estimate.

The SFPUC's Water Supply Master Plan suggested a cost range of \$450 to \$1,000 per acre-foot for water transfers. No background data was given for this estimate.

DWR's estimate assumes a water transfer unit cost range of \$125 to \$500 per acre-foot in 2005 dollars. ED's TREWSSIM model simulation of water transfers shows that transfers occur 6 times within the most recent 30 years of the 73-year time series. Applying the two prices from above (\$125 and \$500) to the 30 years at a discount rate of 6%, the present value of transfer costs range from \$17 to \$66 million. After adding a 30% markup for estimate uncertainty, the cost of the transfers is \$22 to \$86 million.

A3. Cost Estimate for Expanded Water Treatment Facilities

Environmental Defense (prepared by Schlumberger) cited costs for several existing and proposed water treatment plants. The data exhibits a range from under \$1.00 per gallon per day (/gal/day) to \$1.50/gal/day and includes treated water storage components. In its Water System Improvement Program (WSIP), the SFPUC plans to expand the Sunol Valley Water Treatment Plant by 40 mgd at a cost of roughly \$1.33/gal/day, which is in the middle of that range. For this estimate, DWR uses \$1.00 for the low end of the range of additional water treatment costs. A 240 mgd expansion of treatment facilities in the Sunol Valley Plant at a cost of \$1.00/gal/day would cost \$240 million. After adding a 30% markup for estimate uncertainty, the cost of expanded treatment facilities is \$310 million in DWR's estimate.

The SFPUC states the existing Sunol Valley Plant site cannot accommodate the amount of expansion needed to treat a replacement supply; therefore, a new plant would have to be built elsewhere. The SFPUC reports this new plant (referred to as the West Portal treatment facility) was estimated in 1999 to cost \$283 million and the escalated value of this new plant (in 2005 dollars) is \$321 million. The SFPUC's WSIP plans to add 22.5 million gallons of storage to the existing Sunol plant at an estimated cost of \$50 million. Using the same ratio of storage volume to treatment capacity, a storage volume of about 34 million gallons would be required at a new

240 mgd plant, at a similarly extrapolated cost of \$75 million. Therefore, the estimated total cost to expand treatment capability and store the treated water is \$321 million + \$75 million = \$396 million, which equates to a unit cost of \$1.65/gal/day. After adding a 30% markup for estimate uncertainty, the resulting cost is \$515 million. Table G-8 shows the projects and unit costs that serve as the basis for this estimate.

Table G-8. Basis of state estimate for expanded water treatment facilities

Project Name	Project Cost (size)	Unit Cost (\$/gal/day)
South San Joaquin Irrigation District	\$37.5 million (40 mgd)	\$0.94/gpd
Turlock Irrigation District	\$74 million (50 mgd)	\$1.50/gpd
EBMUD's Freeport Regional Treatment Project	\$94 million (100 mgd)	\$0.94/gpd
Olivenhain Water Storage Project	\$98 million (82 mgd)	\$1.20/gpd
St. Joseph Missouri Water Treatment Facility	\$30 million (30 mgd)	\$1.00/gpd
SFPUC's Sunol Treatment Plant Expansion	\$53 million (40 mgd)	\$1.33/gpd
SFPUC cost estimate of 22.5 million gallons of storage for 160 mgd plant	\$50 million (160 mgd)	\$0.31/gpd
Proposed West Portal treatment facility (in 1999 dollars)	\$283 million (240 mgd)	
Escalated cost of proposed West Portal facility (in 2005 dollars)	\$321 million (240 mgd)	
Estimate of 34 million gallons of storage for 240 mgd capacity new treatment plant (West Portal)	\$75 million (240 mgd)	
Combined treatment and storage costs at proposed West Portal site	\$396 million (240 mgd)	\$1.65/gpd
mgd: millions of gallons per day; gpd: gallons per day		

A4. Cost Estimate for Increased Water Use Efficiency (Component 1G)

This estimate assumes a range of 5,000 af to 20,000 af of increased supply from a variety of water use efficiency measures, above and beyond what might be assumed to occur anyway.

Cost estimates for water use efficiency are based on work done by a consultant for the California Bay-Delta Authority's *Water Use Efficiency Comprehensive Evaluation, Fall 2005*. In all, 21 different activities were identified and estimates were made for potential supply and unit cost. The estimates reflect an average weighted unit cost of \$508 per acre-foot in 2020 and \$588 in 2030. The 2020 unit cost was selected as the low end of the cost range and the 2030 unit cost was selected for the high end for DWR's estimate. The cost estimates are shown in the Table G-9.

Table G-9. Basis of State estimate for increased water use efficiency

Activity	2020 Potential (af)	2020 Utility Unit Cost (\$/af)	2030 Potential (af)	2030 Utility Unit Cost (\$/af)
Medical sterilizers	2,070	\$134	2,246	\$163
Landscape budgets	30,551	\$155	33,139	\$189
CII dishwashers	1,953	\$320	2,118	\$391
Residential showerheads: SF	698	\$323	244	\$394
Residential showerheads: MF	513	\$383	3,801	\$424
CII spray valves	3,504	\$424	179	\$467
Residential toilets: MF	23,019	\$433	15,304	\$528
Landscape surveys	2,296	\$453	2,296	\$552
CII surveys	1,870	\$512	1,870	\$625
Other landscape	31,548	\$552	33,930	\$673
Residential ET-controllers: SF	21,188	\$563	23,228	\$687
Medical sterilizers	2,870	\$567	3,114	\$692
BMP	20,455	\$584	20,840	\$712
Residential toilets: SF	19,517	\$711	12,976	\$867
CII toilets: Restaurants	259	\$908	155	\$1,107
Residential washers: SF	-	\$1,002	-	\$1,221
CII toilets: Retail/wholesale	1,813	\$1,067	1,085	\$1,301
Residential washers: MF	-	\$1,269	-	\$1,547
CII toilets: Other	876	\$2,042	524	\$2,489
CII toilets: Office/health	1,634	\$2,134	978	\$2,601
CII toilets: Hotels	429	\$2,667	257	\$3,251
Total Potential (af)/Weighted Ave. Cost (\$/af)	167,064	\$508.28	158,284	\$587.93
BMP=Best management practices; SF= Single family residential; MF= Multi-family residential; CII= Commercial, Industrial, Institutional; ET= Evapotranspiration				

Assuming 5,000 af and average weighted unit costs of \$508 and \$587 per acre-foot, a discount rate of 6%, and a 30-year period, the present value cost ranges from \$35 to \$40 million. Assuming an increase of 20,000 af in water use efficiency yields a cost range of \$140 to \$162 million for the present value. Therefore, the bookend cost range would be \$35 to \$162 million. After adding a 30% markup for estimate uncertainty, the range for the cost of increased supply is \$46 to \$210 million.

The Restore Hetch Hetchy report cites costs of \$425 to \$738 per acre-foot, with an average of \$582 per acre-foot for water reuse/recycling. This is comparable to the Bay-Delta Authority estimates.

A contingency markup was not applied to the increased water use efficiency programs because it was assumed that environmental documentation, permitting, and mitigation would not be required.

A5. Cost Estimate for Increased Annual Operations and Maintenance

To develop cost estimates for annual operations and maintenance (O&M), we took the present worth of annual O&M Costs for the water replacement components and added energy costs to them. A 30% contingency markup was added to cover the uncertainties of estimating these costs. Methodologies for determining operations and maintenance costs and energy costs are described below.

Table G-10. Total operations and maintenance costs including energy costs (in millions)

ID	Component	Energy Cost
A5	Present worth of O&M costs (6%, 30 years)	\$234-\$702
	Present worth of energy costs (6%, 30 years)	\$70-\$502
	Subtotal	\$304-\$1,204
	30% Contingency markup	\$90-\$361
	Total O&M Cost	\$400-\$1,570

For the purposes of DWR's estimate, the annual O&M costs of new facilities have been generalized based on experience with other DWR projects. The costs to operate and maintain a new facility are site specific and are typically not determined until the facility has been in operation for several years.

Annual O&M costs include personnel required to operate, control, and maintain the various facilities, as well as the energy costs to operate the facilities. It is assumed that O&M personnel perform civil maintenance, road maintenance, and mechanical repair on certain equipment.

During economic analyses of the Coastal Branch Project, DWR assumed O&M costs of 2% of the total cost of the project. This allowed for staff time on maintenance and for long-term costs for replacement of major facility components. To date, the 2% cost has proven to be a reasonable assumption.

Annual O&M costs (not including energy costs) were applied to the water and power replacement components in Table G-11.

Table G-11. Summary of annual operations and maintenance costs (in millions)

ID	Component	Total Project Cost	Annual O&M Cost (2% of Total Project Cost)
B1a	New surface storage	\$163-\$1,460	\$3.26-\$29.2
B1b	New groundwater storage	\$150-\$230	\$3-\$4.6
B1c	Don Pedro or SWP Intertie	\$53-\$234	\$1.06-\$4.68
B3	Expand water treatment facilities	\$310-\$515	\$6.2-\$10.3
C1a	New Canyon Tunnel intake	\$70	\$1.4
C1b	Modifications to Kirkwood Powerhouse	\$30	\$0.6
C1c	Pumped connection between Holm Powerhouse and Mountain Tunnel	\$40	\$0.8
	Subtotal	\$816-\$2,579	\$16-\$52
	Annual O&M cost (2% of project costs)	-	\$16-\$52
	Present worth of O&M cost (6%, 30 years)	-	\$234-\$702

Energy Costs

Surface Storage: Environmental Defense estimated a requirement of about 0.8 to 0.88 MWh per acre-foot of water pumped into Calaveras Reservoir. At \$55 per MWh it would cost about \$44 to \$48 per acre-foot to pump the water into the reservoir. Based on a TREWSSIM model simulation, the present value of the energy cost to operate a "Calaveras pumping station" would be about \$19.9 to \$21.9 million.

Groundwater Extraction: Environmental Defense estimated a requirement of about 0.366 MWh per acre-foot of water pumped via groundwater extraction. At \$55 per MWh it would cost about \$20 per acre-foot to pump the water. Based on a TREWSSIM model simulation of groundwater

transfers, the present value of the energy cost to operate a groundwater program would be about \$4.7 million.

Don Pedro Intertie: Environmental Defense estimated a requirement of about 0.15 MWh per acre-foot of water pumped through the Don Pedro Intertie. At \$55 per MWh it would cost about \$8 per acre-foot to pump the water. Based on a TREWSSIM model simulation of water movement through a Don Pedro Intertie, the present value of the energy cost to operate a Don Pedro Intertie would be about \$14.9 million.

SWP Intertie: It is assumed that this would be an incremental cost for additional power to operate the new facilities. Pumping 1 af of Hetch-Hetchy water would require about 0.29 MWh to pump through Banks Pumping Plant and 0.84 MWh through South Bay Pumping Plant for a total of about 1.13 MWh per acre-foot of water pumped. At \$55 per MWh it would cost about \$62 per acre-foot to pump the water. Based on a TREWSSIM model simulation of water transfers, the present value of the energy cost to operate an SWP Intertie would be about \$5.4 million.

Expanded Water Treatment Facilities: Assuming increased water treatment costs per ED (ED, 2004, p.67) beginning 20 years from now and continuing for 30 years, the present value cost at a 6% discount rate ranges from about \$40 million for Tuolumne diversions up to about \$465 million for Delta diversions.

Table G-12. Summary of energy costs (in millions)

ID	Component	Energy Cost
B1a	New surface storage	\$19.9-\$21.9
B1b	New groundwater storage	\$4.7
B1c	Don Pedro or SWP Intertie	\$5.4-\$14.9
B3	Expand water treatment facilities	\$40-\$465
C1a	New Canyon Tunnel intake	*
C1b	Modifications to Kirkwood Powerhouse	*
C1c	Pumped connection between Holm Powerhouse and Mountain Tunnel	*
	Present Worth of Energy Costs	\$70 -\$502
* Energy costs included in "purchase replacement capacity and energy cost" (item C2 in Table G-2)		

B1a,b,c. Cost Estimate for Power Replacement Facilities

This table provides DWR cost estimates of Hetch Hetchy water and power replacement facilities that have been proposed by others; the estimates are based on DWR's experience with recent construction projects, as noted.

Table G-13. State estimates of Hetch Hetchy water and power replacement facilities

Conveyance Options	DWR Estimate				Comments
	Quantity	Unit	Unit Cost	Total Cost	
Tuolumne River Diversion Modifications (Component 1H)					
B1a. Tuolumne River Diversion into Canyon Tunnel					
Intake works	1	Ls	\$9,000,000	\$9,000,000	Predicated on San Bernardino Intake Structure
Pump station and diversion weir (1,500 cfs)	15,670	HP	\$2,080	\$32,593,600	Predicated on Coastal and East Branch Extension Pump Stations, includes: pumps, motors, valves, elec. and mech. work
Pipeline (1,500 cfs)	14,000	Lf	\$630	\$8,820,000	7 each, 6 ft. dia. pipelines, 2,000 ft. each. Used Coastal Reaches 1 and 2, and East Branch Extension Reaches 1 and 2
New adit	200	Lf	\$2,300	\$460,000	Predicated on the tunnel work for West Corral de Piedra and Calf Canyon Tunnel Contracts.
Blocking tunnel from dam	1	Ls	\$200,000	\$200,000	No information, used Restore Hetch Hetchy Estimate
Power line from Early Intake	15	Miles	\$390,000	\$5,850,000	Quotation from SMUD for 230 kV, wooden-pole transmission lines, single circuit, 300 foot pole spacing.
Subtotal				\$56,924,000	
30% markup for estimate uncertainty				\$17,078,000	30% of subtotal cost
Total Cost ¹				\$74,002,000	Total cost does not include 30% environmental documentation, permitting and mitigation or 30% engineering, legal and administration costs
B1b. Kirkwood Modifications, Automation, and Telemetry				\$20,000,000	No information. Used Restore Hetch Hetchy Estimate
30% markup for estimate uncertainty				\$6,000,000	30% of subtotal cost
Total Cost ¹				\$26,000,000	Total cost does not include 30% environmental documentation, permitting and mitigation or 30% engineering, legal and administration costs
Cherry / Eleanor Storage and Operation (Component 1B)					
B1c. Connecting Holm Powerhouse to Mountain Tunnel					
Pumping plant (730 cfs, 300 ft. lift)	1	Ls	\$15,900,000	\$15,900,000	Predicated on Coastal and East Branch Extension Pump Stations. Includes: pumps, motors, valves, electrical and mechanical work
Pipeline (730 cfs, 2 miles) (9 ft. diameter pipe)	10,560	Lf	\$1,100	\$11,616,000	Predicated on Coastal Branch Reaches 1 and 2, East Branch Extension Reaches 1 and 2 , and Mojave Siphon P.P.
Others (transmission line, approximately 1,000 feet long)	0.2	Miles	\$500,000	\$100,000	Predicated on a quotation from SMUD
Connection to Mountain Tunnel, Flow Measurement and Automation	1	Ls	\$3,500,000	\$3,500,000	Predicated on East Branch Extension SCADA, and Coastal Branch Flow Meter Contract and boring a new adit.
Subtotal				\$31,116,000	
30% markup for estimate uncertainty				\$9,335,000	30% of subtotal cost
Total Cost ¹				\$40,451,000	Total cost does not include 30% environmental documentation, permitting and mitigation, or 30% engineering, legal and administration costs
¹ Total cost may differ from main estimate due to rounding differences					
HP= Horsepower; Lf= Lineal feet; Ls= Lump sum; P.P.=pumping plant; SCADA=Supervisory Control and Data Acquisition system					

B2. Cost Estimate for Replacement Power

DOE: In 1988, DOE estimated a levelized annual cost of replacement capacity and energy at \$109 million. Over a 30-year life at 6%, the present value of this cost is \$1.5 billion. This estimate seems high based on other more recent work.

Restore Hetch Hetchy: RHH claims a net energy loss of 550 GWh during a median water year after construction of two physical components (a new diversion into Canyon Tunnel and a pumped connection from Holm to Mountain Tunnel) with an estimated energy replacement cost from “market sources” of about \$30 million/year. RHH recommends that the replacement energy come from efficiency programs and renewable resources, rather than construction of new fossil generation, but admits that new fossil generation would be the cheapest. RHH estimates the cost of replacing 550 GWh from new fossil generation as 14% of the output (energy) of a new 500 MW combined-cycle plant at \$98 million, not including the cost of actually producing the energy, which would be at least another \$20 million/year. For this report, it is assumed that replacing the lost energy from renewable sources would increase capital costs about 20%. Annual costs for renewable resources were assumed to be approximately half that of a fossil resource.

Table G-14. Restore Hetch Hetchy estimates of power replacement costs (in millions)

RHH estimates of power replacement options	Initial	Annual
New diversion facilities for Canyon Tunnel	\$52	—
Modifications to Kirkwood Powerhouse	\$14	—
Pumped connection between Holm Powerhouse and Early Intake Reservoir	\$59	—
Fossil replacement (minimum cost)	\$98	\$20
Renewable replacement (assumed 20% higher)	\$118	\$10

The present value of fossil replacement (30 years at 6%) is about \$498 million. The present value of renewable replacement is about \$381 million.

UCD: Null’s 2003 thesis reports an average annual loss of 457 GWh. Using wholesale energy prices varying between \$18/MWh and \$30/MWh, she estimated an annual replacement cost to the SFPUC system of \$12 million. This estimate seems low because 2005 energy prices have been double and triple those prices; this estimate is for energy alone, no capacity or capital costs are included.

Environmental Defense: Their 2004 publication estimates a minimum of 339 GWh needs to be replaced at an annual cost of \$19 million/year (using a levelized cost of \$55/MWh.) This assumes construction of a pumped connection between Holm Powerhouse and Mountain Tunnel. Without this pumped connection to recover some of the energy, replacement numbers double to 690 GWh at an annual cost of \$38 million/year. Present value of a 30-year series at 6% for these two energy-only replacements is \$262 million and \$523 million, respectively.

Table G-15. Comparison of cost estimates for power replacement by different agencies (in millions)

Name	Initial Cost	Annual Cost	Net Present Value
US Department of Energy	—	\$109	\$1,500
Restore Hetch Hetchy (fossil)	\$223	\$20	\$498
Restore Hetch Hetchy (renewable)	\$243	\$10	\$381
UC Davis	—	\$12	\$165
Environmental Defense (with connection)	\$59	\$19	\$321
Environmental Defense (without connection)	\$0	\$38	\$523

Conclusion: Excluding energy replacement cost estimates from UCD and DOE as “outliers,” this estimate assumes a range of \$321 million to \$523 million. After applying a 30% markup to cover estimating uncertainty, the cost range is about \$420 to \$680 million.

C. Cost Estimate for Dam Removal or Modification

A cost estimate for the removal or modification of O’Shaughnessy Dam was developed by comparing current dam removal projects in the United States: Elwha and Glines Canyon Dams on the Elwha River in Olympia National Park, Washington; Matilija Dam on the Ventura River in Ventura County, California; and San Clemente Dam on the Carmel River in Monterey County, California.

Many permits will be required to remove or modify the dam, including those from the U.S. Army Corps of Engineers, California Department of Fish and Game, Central Valley Regional Water Quality Control Board, and DWR’s Division of Safety of Dams.

The Tuolumne River would be diverted around the active area of construction during the demolition period. Temporary cofferdams would be constructed upstream and downstream of the dam to divert the river into a bypass pipeline to maintain flow in the Tuolumne River during construction.

The existing road from Highway 120 to the dam site may be inadequate for traffic during modification of the dam and is almost certainly inadequate for the traffic involved in removal of the dam. For this estimate, some improvements were assumed to be needed for dam modification. Substantial reconstruction of the road was assumed to be necessary for dam removal.

Removal: Removal of O’Shaughnessy Dam is estimated to take about five years and require transporting about 662,000 cubic yards of concrete away from the dam site and removing approximately 1,560 feet of steel penstock from the dam to power tunnel. The dam foundation would be left in place to retain the hydraulic characteristics of the river. The removal method is assumed to be controlled blasting. Concrete debris would be further milled down at the site to aggregate base rock. A conveyor system is assumed to be constructed to transport the debris to Camp Mather, which is about 9 miles from the dam. Transport by conveyor would likely have less environmental impacts than trucking. At Camp Mather, the debris would be transferred to trucks and hauled to an existing quarry near the intersection of Highways 108 and 120.

After dam removal, removal of the conveyor system would be followed by extensive site restoration and mitigation.

Table G-16 illustrates the magnitude of removing O’Shaughnessy Dam compared to other dams proposed for removal. The total cost for the other projects includes much more than just removal of the dam, such as contingencies, engineering design, administration, environmental mitigation, and other factors specific to the project. For example, for the San Clemente project, the total cost includes removal of 2.5 million cubic yards of sediment from the reservoir and transport by conveyor to an off-site location. For the Matilija project, the total cost includes downstream flood mitigation and removal of fine reservoir sediments by a slurry system to an off-site location. The cost estimate for the Elwha and Glines Canyon dam removal projects includes access road improvements, the removal of other facilities, raising the levees downstream and a new water treatment plant downstream to compensate for a potential rise in the groundwater impacting local septic tanks. For these reasons, the ratio of total project costs per cubic yard of concrete volume cannot be used to estimate the removal cost of O’Shaughnessy Dam.

Table G-16 compares the size of O'Shaughnessy Dam to other concrete dams currently proposed for removal. Table G-16 compares various categories of estimated direct costs for these other dam removal projects. The DWR estimate for removal of O'Shaughnessy Dam is based on details extracted from these other dam removal projects and is shown in Table G-17.

Table G-16. Comparison of O'Shaughnessy Dam to other dam removal projects

Dam Name	Height	Concrete Volume	Total Cost	Comment
San Clemente	85 feet	7,000 cubic yards	\$87 million	Requires sediment removal
Elwha	108 Feet	20,000 to 27,000 cubic yards	\$182.5 million	2004 cost estimate for both dams
Glines Canyon	190 Feet	16,800 cubic yards		
Matilija	163 Feet	51,000 cubic yards	\$104 million (Alt. 4B)	Requires slurry of fine sediment from reservoir
O'Shaughnessy	312 Feet	662,000 cubic yards		

Table G-17. Comparison of direct costs (unit costs in parentheses) from other dam removal cost estimates

Item Description	San Clemente Dam (7,000 cubic yards) Mar. 2005	Elwha Dam (20,000 cubic yards) Apr. 2003	Glines Canyon Dam (16,800 cubic yards) Apr. 2003	Matilija Dam (Alt. 4B) (51,000 cubic yards) Jul. 2004
Mobilization/equipment management	\$900,000	\$460,000	\$2,300,000	\$2,500,000
Contractor indirects	\$2,700,000			
Traffic controls	\$30,000			
Construction permits/plans	\$190,000			
Access road improvements	\$995,000 (\$199,000/miles for 5 miles)	\$60,000 (\$100,000/miles for 0.6 miles)	\$12,000 (\$60,000/miles for 0.2 miles)	\$100,000
River bypass	\$2,500,000	\$1,212,500		\$300,000
Site preparation	\$270,000		\$16,200	\$1,595,000
Dam demolition by controlled blasting	\$2,100,000 (7,000 cubic yards at \$300/cubic yards)	\$3,233,000 (20,000 cubic yards at \$162/cubic yards)	\$6,828,460 (16,800 cubic yards at \$406/cubic yards)	\$5,202,400 (51,000 cubic yards at \$102/cubic yards)
Concrete removal by trucking		\$1,104,000 (184,000 cubic yards at \$6/cubic yards for 10 miles)	\$201,600 (16,800 cubic yards at \$12/cubic yards for 20 miles)	\$1,951,695 (72,285 cubic yards at \$27/cubic yards for 28 miles)
Sediment removal				
A) By Conveyor (incl. purchase, construction and power)	\$20,625,000 (approx. 1 miles)			
B) By Slurry (incl. water, real estate for right of way, power)				\$15,585,915
Demobilization	\$75,000			\$2,500,000
Site restoration	\$2,040,000	\$361,400	\$30,000	
Downstream flood mitigation components				\$12,833,400
O&M				\$1,211,900
Subtotal Cost *	\$38,885,000	\$10,435,500	\$9,665,600	\$64,623,212
* Subtotal Cost includes other cost items not listed in the above table. Also, the subtotal cost is intended to compare unit prices and does not include contingencies, environmental mitigation, design, administration, escalation to time of construction, or other factors.				

Note: Some cells are blank because information may not apply or is unknown.

Table G-18. State estimate for removal of O'Shaughnessy Dam

Description	Quantity	Unit	Unit Cost	Total (millions)	Comments
Mobilization / Equipment Management and Preparatory	1	Ls	\$40-50	\$40-\$50	
30% markup ¹				\$12-\$15	
Subtotal Cost²				\$52-\$65	
Deconstruct Dam					
Contractor indirects	1	Ls	\$40-50	\$40-\$50	Subcontracts, equipment rental, etc.
Traffic controls	1	Ls	\$5-10	\$5-\$10	Flaggers, labor, signals, etc.
Construction permits/plans	1	Ls	\$10-15	\$10-\$15	
Highway 120 impacts	41	M&I	n/a	0	26,000+ legal "transfer" loads
Evergreen Road impacts	9	M&I	\$3-3.5 million	\$27-\$29	Initial improvements and post project repairs
Hetchy Hetchy Road impacts	12	M&I	\$3-3.5 million	\$36-\$42	Initial improvements and post project repairs
River bypass	1	Ls	\$5-10	\$5-\$10	Temporary cofferdam, bypass pipe, emergency control measures
Dam demolition by controlled blasting	600,000	CY	\$250-275	\$150-\$165	Drill and blast, process concrete, remove and dispose of metal
Conveyor system	1	Ls	\$180-\$200	\$180-\$200	Purchase, construction, and power needed for conveyor system (9 mi. from dam to Camp Mather)
Haul Concrete to Quarry Site	600,000	CY	\$50 -\$ 60	\$30-\$36	(50 miles from Camp Mather to existing quarry)
Remove 1560 ft. of steel penstock	1	Ls	\$10.-\$15	\$10-\$15	
Site restoration and mitigation	1	Ls	\$40 -\$ 50	\$40-\$50	
Base subtotal cost to deconstruct dam				\$533-\$622	
30% markup ¹				\$160-\$187	
Subtotal Cost²				\$693-\$810	
Demobilization	1	Ls	\$25 -\$ 30	\$25-\$30	
30% markup ¹				\$8-\$9	
Subtotal Cost²				\$33-\$40	
Total Cost²				\$778-\$915	Total may differ from main estimate due to rounding
¹ 30% markup for uncertainty in estimating costs					
² Subtotal and Total costs may differ from main estimate due to rounding.					
CY=cubic yards; Ls=lump sum; M&I=municipal and industrial					

Modification: Modification of O'Shaughnessy Dam to eliminate impoundment has been suggested as a means of reducing the cost of restoring Hetch Hetchy Valley. For purposes of this estimate, construction of a 40-foot-wide by 35-foot-tall hole was assumed. This size hole is assumed to pass the 100-year flood of about 62,000 cfs.

Modification was assumed to require removal of about 13,000 cubic yards of concrete. This volume of debris was assumed to be moved up to a staging area (the current parking area) by conveyor and then moved by small dump trucks all the way to the disposal quarry. No material transfer would be necessary at Camp Mather.

The smaller number of trips coupled with the weight of using smaller trucks would reduce the need for initial road improvements and would likely reduce the need for post-project repair or replacement. A local roadway “impact fee” of \$2.50 per ton was assumed in lieu of roadway repair or replacement.

The protection of the structural integrity of remaining concrete during modification was assumed to increase concrete demolition costs by a factor of ten for modification over the cost of removing the dam.

Table G-19 summarizes the cost estimate for dam modification. The estimate to remove O’Shaughnessy Dam ranges from \$778 to \$915 million. The estimate to modify the dam ranges from \$250 to \$345 million. Therefore, using the bookend approach, the cost range becomes \$250 to \$915 million.

**Table G-19. State estimate for modification of O’Shaughnessy Dam
(40 ft. by 35 ft. hole through base of dam)**

Description	Qty	Units	Unit Cost	Total (millions)	Comments
Mobilization / Equipment Management and Preparatory	1	Ls	\$30-\$40	\$30-\$40	
30% markup ¹				\$9-\$12	
Subtotal Cost²				\$39-\$52	
Deconstruct Dam					
Contractor indirects	1	Ls	\$30-\$40	\$30-\$40	Subcontracts, equipment rental, etc.
Traffic controls	1	Ls	\$5-\$10	\$5-\$10	Flaggers, labor, signals, etc.
Construction permits/plans	1	Ls	\$10-\$15	\$10-\$15	
Highway 120 impacts	41	M&I	n/a	0	2,000 small dump truck trips
Evergreen Road impacts	15	ton	\$2.50	\$1	1.6 tons per cubic yards for a total of 13,000 cubic yards over county roads
Hetch Hetchy Road impacts	12	M&I	\$1-\$2	\$12-\$24	Approx. haul distance within Yosemite National Park
River bypass	1	Ls	\$5-\$10	\$5-\$10	Temporary cofferdam, bypass pipe, emergency control measures
Dam demolition by controlled blasting	13,000	CY	\$2,500 – \$2,750	\$32-\$36	Drill and blast, process concrete, remove and dispose of metal
Conveyor system	1	Ls	\$1-\$2	\$1-\$2	Construct conveyor system from streambed to staging area (1,000 ft.)
Haul concrete to quarry site	13,000	CY	\$80-\$100	\$1-\$2	Existing quarry site near intersection of Highways 108 and 120
Remove 1,560 ft. of steel penstock	1	Ls	\$10-\$15	\$10-\$15	
Site restoration and mitigation	1	Ls	\$30-\$40	\$30-\$40	
Base subtotal cost for deconstruct dam				\$137-\$195	
30% markup ¹				\$41-\$59	
Subtotal Cost²				\$178-\$254	
Demobilization	1	Ls	\$25-30	\$25-\$30	
30% markup ¹				\$8-\$9	
Subtotal Cost²				\$33-\$39	
Total Cost²				\$250-\$345	Total may differ from main estimate due to rounding
¹ 30% markup for contractor payment contingencies					
² Subtotal and Total costs may differ from main estimate due to rounding differences					

D. Cost Estimate for Valley Restoration

RHH developed an estimate for restoration. Their estimate of \$20 million included most major program elements, so it was used as a template for developing a DWR restoration estimate. Resources from the Internet and from personal communications (such as e-mail) were utilized for data on components in the RHH budget and on additional budget components and then the resources were used to adjust individual items. Program elements that were not included in the RHH estimate include design and engineering, environmental permitting, and project management.

Restoration project costs were also broken down on a per-acre basis and used as a rough gauge for comparing costs. Restoration costs vary widely, from \$4,000 per acre for small, simple projects (see Big Flat Meadow at <http://www.feather-river-crm.org/projects.htm>) to more than \$500,000 per acre for large, complex projects (Zentner and others 2003).

The RHH estimate proposes planting almost 100% of the area, but the cost could be reduced by planting a smaller percentage of the valley. For instance, NPS (Riegelhuth 1988) proposed planting only 25% of the areas exposed after the valley was drained. DWR's amended estimate includes figures for both 100% revegetation and 50% revegetation.

DWR's estimates for the Hetch Hetchy Valley restoration are \$46 million at a planting rate of 100%, and \$28 million at a planting rate of 50%, or roughly \$35,500 and \$21,500 per acre, respectively. These per-acre estimates are comparable with the cost of other restoration projects.

Table G-20. Estimated costs for Hetch Hetchy Valley restoration at both 100% and 50% revegetation

Item Description	Cost at 50% Revegetation	Cost at 100% Revegetation
Refill quarry excavations and recontour ¹	\$846,000	\$846,000
30% markup for estimate uncertainty	\$253,800	\$253,800
Revegetation and stream restoration ²	\$23,231,000	\$38,640,000
30% markup for estimate uncertainty payment contingencies	\$6,969,300	\$11,592,000
Maintenance and monitoring (3-year base)	\$981,000	\$1,650,000
Total cost³	\$32,281,000	\$52,981,800
¹ Volumes of material are from RHH estimate, but costs increased as per e-mails from Kevin Faulkenberry, Senior Engineer with DWR, and Laurie Archambault, California Department of Parks and Recreation (DPR).		
² Plant species and numbers are from RHH estimate, but costs for individual plants were increased using data from an e-mail from Laurie Archambault, Senior Resource Ecologist with DPR.		
³ Total cost may differ from main estimate due to rounding.		

E. Cost Estimate for Visitor Use Opportunities

This cost estimate assumes, at the low end, that the restored valley is administered as wilderness. This section also outlines the moderate development of visitor use opportunities once the valley is sufficiently restored. Further details and scope would be identified in a visitor use plan to be developed through the National Park Service.

Entrance Station: \$700,000

- ADA-compliant, wood-framed entrance building. Building includes office area, semi-private work area, and toilet room. Built-in items include interior counter space and floor safe. Exterior would be redwood board siding, stone veneer, and cedar shake roofing.

Visitor Center: \$4,450,000 (\$850/square foot) for building (with minimal interpretive displays)

- Construct new 4,000 square foot visitor and cultural center (ADA compliant)
- Concrete block, exterior walls with stone façade/veneer; cedar shake or shingle patterned metal roof; parking; lighting; and associated site work
- Interpretive exhibits: minimum amount (does not cover all costs such as natural/cultural hands-on exhibits, electronic media, supporting workspace, storage facilities, curation, etc.)

Interpretive Panels (exterior): \$20,000/panel

- Design and fabricate 20-30 interpretive panels
- Develop and install interpretive displays according to the resource inventory and visitor use plan
- Develop panels to be ADA compliant

Restroom (Comfort Station): \$900,000

- 300 Series ADA-Compliant Combination Building (741 square feet). Two accessible shower/toilet rooms, four non-accessible toilet rooms, and four non-accessible shower rooms.

Recreational Vehicle (RV) Sites: \$90,000

- Each site (4,500 square feet) will provide:
- Paved parking for an RV vehicle and an accompanying motor vehicle
- Water, electricity and sewer or septic hook-up (or sanitation station)
- Park furniture, including a food locker, table, and fire ring

Tent Sites: \$70,000

- Each site (4,000 square feet) will provide:
 - ♦ Paved parking for two motor vehicles
 - ♦ Level tent site
 - ♦ Park furniture, including a food locker, table, and fire ring

Group Sites: \$300,000

- Equivalent of 6 campsites

Paved road: \$1.3 million per mile

- 24-foot-wide, 2 inch A/C (Aggregate/Cement) over 8 inch A/B (Aggregate/Binder), with grading

Pedestrian Trail: \$150,000 per mile

- Unpaved
- ADA compliant
- Includes soil stabilization and adequate drainage

Table G-21. Range of cost estimates for visitor use opportunities

Item	Unit Cost	Low Range		High Range	
		Quantity	Total Cost (in millions)	Quantity	Total Cost (in millions)
Miles of roads	\$1,300,000			25	\$32.5
RV sites	\$90,000			80	\$7.2
Tent sites	\$70,000			140	\$9.8
Group sites	\$300,000			6	\$1.8
Restrooms	\$900,000	1	\$0.9	6	\$5.4
Entrance stations	\$700,000	1	\$0.7	3	\$2.1
Interpretive panels	\$20,000	20	\$0.4	30	\$0.6
Miles of trails	\$150,000	10	\$1.5	40	\$6.0
Visitor Center	\$4,450,000	1	\$4.5	1	\$4.5
Subtotal Cost			\$8		\$70
30% markup for estimate uncertainty			\$2		\$21
Total Cost ¹			\$10		\$91

¹ Total cost may differ from main estimate due to rounding

Concession-type opportunities, including overnight facilities and food establishments, may be identified. Costs for these may be the responsibility of the concessionaire depending on the visitor use plan.

F. Environmental Documentation, Permitting and Mitigation

A markup of 20% to 30% was added to the direct costs (which already include a contingency to cover uncertainty in estimating actual costs) for all items to account for site-specific environmental documentation, permitting, and mitigation expenses. These costs are over and above programmatic planning costs. A range was used to account for variation in the breadth and depth of site-specific work required.

G. Engineering, Legal and Administration

A 30% markup was added to direct costs (which already include a contingency to cover uncertainty in estimating actual costs) for all items to account for engineering, legal, and administration costs during final design and construction. This includes items such as final planning, engineering investigations, designs, construction management, legal counsel, and general project administration.

Cost Estimating Methodology

The cost estimates developed for this report are based on DWR's experience with the planning and construction of similar projects, and include limited environmental protection and risk mitigation for California water management. The total direct cost for each facility component includes a 30% markup for uncertainty in estimating the actual cost. This contingency covers inaccuracies in quantity estimation, an allowance for unlisted items (to account for minor items that have not been incorporated), and other unknowns at the time of the estimate. This is consistent with DWR's standard estimating practices at this level of conceptual study. To account for site-specific environmental documentation, permitting and mitigation expenses a markup of 30% was added to the total direct costs (which already include a contingency to cover uncertainty in estimating actual costs) for each facility component. A 30% markup was also added to the total direct costs to account for engineering, legal, and administration costs during construction.

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APPENDIX H. RESTORATION PROJECT MANAGEMENT STRUCTURES

Other major environmental and restoration projects in California and around the country have drawn on different management structures during different stages of the project. However, three general structures emerge from the case review, described below.

- *Government-Run Study*. This approach relies on government expertise to direct and conduct the analysis. For a large, complex issue, this could be a multi-agency study like what is occurring in the Florida Everglades. These processes usually rely on public and stakeholder advisory bodies to provide advice and feedback from non-governmental stakeholders and the public.
- *Government-Appointed Task Force*. Projects around the country do not use the term “task force”, in a consistent way. In some cases it means a stakeholder group that will negotiate a result similarly satisfactory (or unsatisfactory) to all parties. In other cases it means a panel of experts or distinguished leaders that bring a neutral, unbiased approach to the problem, which is the spirit in which the term is used here. Parties expect such a task force to conduct a transparent and unbiased study of the issues; listen to stakeholders, the public, and the experts; and then make recommendations to government. The credibility of the task force with stakeholders, government officials, and the public is key to its success. An example is the California’s Marine Life Protection Act (MLPA) Blue Ribbon Task Force.
- *Collaborative Stakeholder Process*. In the two models described above, stakeholders may be consulted or have a formal advisory role. In the third model, labeled here as a collaborative stakeholder process, they are directly involved in setting up and overseeing the investigation. Terms commonly used to describe this process are “collaborative analysis” and “joint fact-finding.” The Sacramento Area Water Forum is such a process.

This chapter contains a brief discussion of these models in terms of major environmental mitigation or restoration projects that have utilized them. As you review these examples, keep in mind that in some cases, the management framework changed over time with changes to the level of consensus surrounding the project. For example, the first significant steps in the Florida Everglades restoration program, which we describe below, were taken by a stakeholder commission appointed by the governor that framed the issues. As a consensus emerged, the project gained momentum and evolved into a federally-run feasibility study and then a multi-decade restoration program. Also keep in mind that each of these models has its own advantages and disadvantages. The challenge is to find the model that best fits the characteristics of the issues involved and the level of consensus (or lack thereof) on the need for the project.

1988 U.S. Bureau of Reclamation Feasibility Study Plan

The 1988 report by the U.S. Bureau of Reclamation (Reclamation) analyzed the “idea” to restore Hetch Hetchy “and identified concepts for replacing water and power supplies. That same report delineated the foundation for a feasibility study to look at the benefits, impacts, and costs of restoring Hetch Hetchy Valley. Reclamation assumed the National Park Service (NPS) would address development and use of the valley in separate but coordinated studies. The feasibility, or plan formulation, studies identified by Reclamation were focused on the manner of water and power replacement, including:

- Defining the replacement requirements, i.e., the water, power, and revenues that would be reduced with the restoration of Hetch Hetchy Valley;
- Developing costs, accomplishments, impacts, and acceptability for potential replacement options;
- Selecting a preferred replacement plan;
- Developing detailed alternative methods for physically removing O’Shaughnessy Dam; and
- Preparing and processing a Planning Report/Environmental Statement, including recommendations, which describe the study and are suitable as the basis for appropriate action by Congress.

The Reclamation proposal outlined a study plan with the following three water and power replacement categories:

- Reoperation of the Tuolumne River System
- Balance of Replacement Supplies: Sierra Nevada
- Balance of Replacement Supplies: Bay-Delta.

Each category was described in terms of its physical and operational aspects, legal and institutional issues, and environmental considerations. The plan was derived from limited information at the time and therefore stated that the feasibility study plan was not all inclusive. Reclamation expected that as the study progressed and the public actively participated in the decision-making process, more topics would arise and be included.

A five-year work schedule was proposed with an estimated budget of about \$3 to \$5 million, exclusive of any specific planning required by the NPS. It was expected that about \$500,000 would be required in the first year of study.

Government-Run Study Example: Comprehensive Everglades Restoration Plan

The Comprehensive Everglades Restoration Plan (CERP) has been described as the “most ambitious ecosystem restoration effort ever undertaken in the United States.”³³ The multi-billion dollar effort will capture and store large amounts of fresh water in reservoirs for environmental restoration, as well as for municipal and agricultural uses. Planning and analysis have been under way for many years, and the facilities will take decades to construct.

The feasibility study for the Everglades was too big to be done all at once. Congress authorized a federal Everglades restoration study in 1992, and the U.S. Army Corps of Engineers (USACE) completed a “reconnaissance” phase by 1994. However, the federally-led process did not produce serious feasibility studies until after a stakeholder process at the state level. From 1994-1996,

³³ Central and Southern Florida project, “Environmental and economic Equity Program Management Plan, Comprehensive Everglades Restoration Plan,” August 2001.

there were two “framing the issues” studies by a Governor’s Commission. This was a group of 37 stakeholder representatives appointed by the governor. This commission’s work fed into the federal effort. In 1996, Congress called for a feasibility study by USACE and directed that it take into account the results of the stakeholder process. USACE carried out the work in partnership with the South Florida Water Management District. They completed the feasibility study in 1999.

In 2000, Congress enacted the Water Resources Development Act, recognizing the comprehensive plan, now known as the Comprehensive Everglades Restoration Plan, as the framework for modifications to the federal water and flood control programs in central and south Florida. The South Florida Water Management District and USACE are responsible for implementing these changes.

Government-Appointed Task Force Example: Marine Life Protection Act Blue Ribbon Task Force

The Marine Life Protection Act of 1999 directed the California Fish and Game Commission to develop a master plan for siting, management, monitoring, funding and enforcement of marine protected areas.³⁴ After an unsuccessful first effort, the California Resources Agency, the California Department of Fish and Game (DFG), and the Resources Legacy Fund Foundation³⁵ entered into a memorandum of understanding (MOU) to carry out the California MLPA Initiative. The MOU contains several key provisions:

Governance/Outside Involvement

The MOU provides that the Resources Secretary will appoint 7-10 advisors to an unpaid California MLPA Blue Ribbon Task Force. The task force advises the Resources Secretary and serves at his pleasure. The members of the task force are listed here to illustrate the stature of the appointees: Phil Isenberg, Chair (former legislator); William W. Anderson (President and Chief Executive Officer of Westrec Marinas and former manager with National Park Service); Meg Caldwell (Director of the Environmental and Natural Resources Law and Policy Program at Stanford Law School); Ann D’Amato (Chief of Staff to the Los Angeles City Attorney and a member of the U.S. Commission on Ocean Policy); Susan Golding (former Mayor of San Diego and President and Chief Executive Officer of the Golding Group); Dr. Fernando J. Guerra (Director of the Center for the Study of Los Angeles at Loyola Marymount University); Dr. Jane G. Pisano (President and Director of the Natural History Museum of Los Angeles County); Catherine Reheis-Boyd (Chief Executive Officer and Chief of Staff for the Western States Petroleum Association); and Douglas P. Wheeler (former Resources Secretary).

Outside technical experts advised the task force. The MOU provided that DFG will establish an external scientific peer review of the master plan. Also, the MOU provided that DFG will establish a science advisory team that will include staff from DFG, the California State Parks, and the State Water Resources Control Board, to be designated by each of those departments. State law provided that this group must include five to seven scientists and one member, appointed from a list prepared by California Sea Grant, who must have direct expertise with ocean habitat and sea life in California marine waters.

³⁴ <http://www.dfg.ca.gov/mrd/mlpa/mou.pdf>.

³⁵ The Resources Legacy fund Foundation is a fiscal agent for a consortium of private foundations including the David and Lucile Packard Foundation, the Gordon and Betty Moore Foundation, and the Marisla Foundation.

In addition, one member of the task force will select a Central Coast MLPA stakeholder group, which will also advise the task force. The parties committed in the MOU to conducting the process in a transparent way, with open, publicly noticed meetings whenever a majority of the task force convenes. Also, the task force and science advisory team will provide regular opportunities for public and stakeholder input.

Deadlines/Milestones

The MOU established the process and various deadlines for its activities. For example, it directed the task force to submit the Master Plan Framework to the Fish and Game Commission by May 2005. It also called for an agreement among the various state agencies that will achieve full implementation of the master plan by 2011.

Funding/Staff Support

The Resource Legacy Fund Foundation and the State of California provided staff support and funding to the project. The foundation provided the executive director, operations and communications manager, and two project managers. The Resources Agency provided senior level support, as well as office space and clerical support.

Upon request of the task force, the foundation can contract with third-party experts and consultants to assist the task force. In addition, the legislature provided \$500,000 to the DFG in the 2004-05 Budget Act, and the foundation provided \$750,000 to fund DFG staff.

According to an August 2004 *The Mercury News* article, the Resource Legacy Fund Foundation has pledged approximately \$2.5 million per year for the effort.

Collaborative Stakeholder Process Example: The Water Forum

The Water Forum was convened in order to identify ways to meet the consumptive water needs of Sacramento, El Dorado, and Placer counties while also meeting demands of the Endangered Species Act on the Lower American River. As characterized in the Water Forum's MOU, negotiated at the onset of the process, its two main objectives were to: (1) provide a reliable and safe water supply for the region's economic health and planned development to the year 2030; and (2) preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River. The stakeholder group made all policy decisions and hired the Center for Collaborative Policy, based at California State University, Sacramento, to assist.

Water Forum Process and Governance

The Sacramento City-County Office of Metropolitan Water Planning convened the process. It began in 1993 and resulted in an agreement in 1999. The agreement became the preferred alternative in a programmatic Environmental Impact Report (EIR) for the region. It addresses cumulative impact issues associated with the overall program. Individual water supply projects must still comply with the California Environmental Quality Act, but can rely upon the programmatic EIR for addressing regional and cumulative impacts.

Stakeholder Involvement

There were 23 parties to the negotiation, including water purveyors, environmentalists, local governments, special districts, "good government"/taxpayer organizations, and the business community. During the six years of negotiations, stakeholder representatives continually presented draft proposals to their boards to obtain their ongoing feedback. In addition, the Water Forum conducted more than one-hundred meetings with community organizations, chambers of

commerce, citizen advisory councils, civic groups, resources agencies, statewide environmental groups, and federal and state water users to solicit their input to the proposals under consideration.³⁶

Funding and Technical Support

The Center for Collaborative Policy provided strategic planning, facilitation, and mediation services to the forum. City and county governments funded the effort in the amount of \$13 million. The forum spent about one-half of the funds on technical work, much of which was done by private consultants. According to the project manager with the Center for Collaborative Policy, stakeholders reached agreement on the choice of technical consultants relatively easily, although this is not necessarily typical.

³⁶ Water Forum Agreement, <http://www.waterforum.org/AGREE.html>.

APPENDIX I. WORKSHOP MATERIALS

Facts

In fall 2004, Governor Arnold Schwarzenegger directed the California Resources Agency to review and summarize existing studies and analyses on the restoration of Hetch Hetchy Valley.

Although Hetch Hetchy is not a state-owned or operated facility, changes to the system would have impacts on California's natural resource management activities and responsibilities, including water and energy supplies, ecosystem impacts, water quality, recreational and economic considerations.

Consistent with its mission to manage the state's natural resources, experts from the Department of Water Resources and the Department of Parks and Recreation are reviewing Hetch Hetchy Valley restoration reports and studies that have been prepared by other organizations and public agencies over the past 20 years.

By reviewing the range of conclusions and considerations in these existing studies and evaluating the likely costs of the project, the state can provide additional information to support the public policy discussions surrounding the future of Hetch Hetchy.

The state's role is to encourage an informed public dialogue on the issue—not to take a position pro or con. The state is serving as a neutral third party, gathering data to provide a balanced view. The Hetch Hetchy investigation will be completed in fall 2005.

July 14 Workshop

On July 14, 2005, a public workshop was held at the CalEPA Building in Sacramento for the Hetch Hetchy Study. Through the use of a facilitator and display stations supported by different subject area experts, the state solicited comments regarding its evaluation framework and initial observations. The subject areas covered at the workshop are listed below:

- Evaluation Process, Framework and Scope
- Legal and Institutional Considerations
- Recreation
- Restoration
- Cultural Resources
- Economics
- Dam Removal
- Facility Components
- Operations Modeling
- Water and Power Management
- Water Quality/Treatment
- Environmental

From the initial observations, it is clear that insufficient evidence exists—from both the benefit and the cost perspectives—to support a final decision on whether or not to remove the dam and restore the valley. The final report will package the comments and questions from the workshop, which will be important in shaping what happens beyond the study.

Background

Hetch Hetchy is a glacial valley in Yosemite National Park currently flooded by O'Shaughnessy Dam on the Tuolumne River.

The valley was called "Hetch Hetchy" as early as the 1860s. The name means either "acorns" or "edible seeds" in the Native American Miwok language.

In 1903, the City of San Francisco applied to the United States Department of the Interior to gain water rights to Hetch Hetchy. This provoked a 10-year environmental struggle with the Sierra Club.

The struggle ended in December 1913 with the passage of the Raker Bill, which permitted flooding of the valley. Construction of the dam began in 1914 and was completed in 1923.

Hetch Hetchy supplies an average of 220 million gallons per day of high-quality water to more than 2.4 million people in the San Francisco Bay Area. The water is transported to the Bay Area through a pipeline and tunnel system more than 150 miles long.

Hetch Hetchy water exceeds federal and state quality standards and is not filtered. San Francisco has the largest unfiltered water supply on the West Coast, and it is one of a small number of unfiltered city water supplies in the nation.

Hetch Hetchy generates an annual average of 1.7 billion kilowatt-hours of hydroelectricity. Some of the power is used for city and county of San Francisco offices and services, including MUNI and the International Airport. Surplus power is sold to Central Valley irrigation districts and public agencies.

In 1987, Secretary of the Interior Donald Hodel proposed the restoration of Hetch Hetchy Valley, and directed the U.S. Bureau of Reclamation to prepare a reconnaissance-level review of this concept on behalf of the National Park Service. The U.S. Department of Energy, Assembly Office of Research, and the Department of Water Resources also studied the subject at that time. Recent studies by Environmental Defense and the University of California, Davis have renewed public and legislative interest in restoring Hetch Hetchy Valley.

Study Status

The Hetch Hetchy investigation was expected to take eight to ten months, with completion in fall 2005. The process began with a review of existing reports and dialogue with key stakeholders and agencies. Information on study scope, schedule, and relevant resource plans is available to the public online at (<http://hetchhetchy.water.ca.gov>).

Appendix I Contents

This appendix contains copies of the posters used at the July 2005 workshop. They are provided as PDFs on this CD; they are tabloid-size pages (11 x 17 inches).

Matrices

- Existing Works – Water Quality
- Existing Works – Recreation Assessment
- Existing Works – Restoration
- Available Information on Hetch Hetchy Cultural Resources
- Existing Works – Dam Removal
- Existing Works – Restoration Tradeoffs and Benefits
- Existing Works – Water and Power Supply Replacement
- Existing Works – Modeled Water Management Alternatives
- Existing Works – Detailed Information on Water & Power Supply
- Existing Works – Source Material for Information on Environmental Impacts
- Existing Works – Overall Summary (2 pages)

Posterboards

- Dam Removal and Cost Considerations
- Economics
- Environmental Considerations
- Evaluation Process
- Existing Information – Water Management Components
- Hetch Hetchy Removal: Legal Considerations
- Operations Modeling
- Recreation
- Restoration
- Water Management
- Water Management Components
- Water Quality

APPENDIX J. PUBLIC COMMENTS

Summary of Comments

On July 14, 2005, the Resources Agency held a public workshop to discuss the initial observations of the state's review of existing Hetch Hetchy Valley restoration studies and to solicit comments from the public and interested agencies. In response, some comments were submitted at the workshop, some were sent by e-mail, and others were submitted through standard mail. The comments are summarized below and a list of respondents is provided in Table J-1. All comment letters are available on the website at <http://hetchhetchy.water.ca.gov>.

Comment Letters Received Through Standard Mail

The majority of comment letters (21 out of 25 letters) came from the Bay Area Water Supply and Conservation Agency (BAWSCA) and its member agencies. BAWSCA expressed concern about the risks to safety, health, and the economic well-being of the people and cost to taxpayers posed by the draining of Hetch Hetchy Reservoir or tearing down of O'Shaughnessy Dam. They asked the state study to endorse five major requirements stipulated by them before any responsible decision can be made about whether or not to drain Hetch Hetchy Reservoir. The five requirements are:

- 1) no delay in rebuilding the earthquake-vulnerable Hetch Hetchy system caused by a program to drain the reservoir or destroy the dam,
- 2) no change in the quality of water delivered to San Francisco's customers,
- 3) no increase in the cost of water for San Francisco's customers,
- 4) no change in physical facilities or institutional arrangements should reduce water supplies or expose existing and future water customers to more frequent or severe water shortages, and
- 5) no modification to the existing water system or its operation until all replacement facilities are funded, built, and operational, and all institutional arrangements are in place and fully funded.

BAWSCA also provided the Department of Water Resources (DWR) and the Department of Parks and Recreation with their observations about the May 2004 study prepared by Jessica Rider entitled "The Potential Economic Benefit of Restoring Hetch Hetchy Valley". They stated that the study is technically flawed and substantially overstates the economic benefits of removing O'Shaughnessy Dam.

The San Francisco Public Utilities Commission (SFPUC), also a BAWSCA member, submitted a memorandum letter to DWR summarizing their cost estimate to restore the Hetch Hetchy Valley, as well as the findings of four technical reports that were prepared for them by various consultants. Three of the four reports cover reviews of hydropower, water quality, and legal issues as described in Environmental Defense's report *Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley*. The fourth report is an assessment of the flood control impacts of removing O'Shaughnessy dam. The report titles are as follows:

- *Assessment of the Flood Control Impacts of the Removal of Hetch Hetchy Dam and Reservoir, Tuolumne River, California*. May 2005. MBK Engineers.

- *Response to Legal Issues Raised by Environmental Defense Proposal*. May 2005. Ellison, Schneider & Harris.
- *Water Quality Review of Environmental Defense's 'Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley'*. May 2005. Camp Dresser & McKee.
- *Review of Environmental Defense's Estimates of the Cost to Replace Lost Hydropower*. June 22, 2005. Robert F. Logan.

In response to SFPUC's memorandum letter and its supporting technical reports, Environmental Defense submitted a letter to DWR providing information supplemental to their report *Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley*. Environmental Defense also submitted a letter to DWR in response to a letter DWR received from the Bay Area Council dated July 5, 2005.

Turlock Irrigation District (TID) submitted a letter to DWR commenting that the recent studies done on Hetch Hetchy have misinterpreted the water right agreements between TID, Modesto Irrigation District (MID) and San Francisco. TID suggested that the long and complicated history between TID, MID, and San Francisco be carefully reviewed before making assumptions about water supplies.

Comments Received at the Workshop

At the July 14, 2005, workshop, a few editorial comments were received. Some respondents wanted to see more existing facilities on the poster boards.

One respondent wanted to find out how the reoperation of Don Pedro Reservoir will affect cold water supply for downstream salmon in the fall.

Restore Hetch Hetchy suggested that recycling water in the Bay Area should be stated as a water supply alternative on the Water Management poster board. They stated that the use of recycling water for heat rejection in cooling systems should be considered. They suggested that the state should look at the data available from SFPUC and East Bay Municipal Utility District (EBMUD) on the new water recycling system for golf courses where tertiary recycled water is being used in place of fresh potable water.

One respondent suggested considering the sensitivity of dam removal in a national park. A conveyor system was suggested as an ideal way to move crushed concrete from the dam site to outside the park. It was further suggested that rock plumbs be placed to backfill the existing quarry pits on the Hetch Hetchy valley floor.

A few comments suggested modification of O'Shaughnessy Dam rather than its removal. One respondent wanted the state to consider the costs and benefits of modifying O'Shaughnessy Dam to allow the river to flow through and use the existing structure for a hotel foundation and he suggested selling the dam to a world-class hotel chain.

It was suggested that the state should review the John Freeman Report³⁷ for a historical perspective and details of the blueprint for the construction of the entire system.

As a part of the economic review and evaluation, one respondent wanted the state to consider an improved lake recreation alternative with improved road access, parking and a non-motorized boat marina.

³⁷ John R. Freeman. 1912. *The Hetch Hetchy Water Supply for San Francisco*. Report written for the City of San Francisco.

Comments Received Through E-mail

Some of the e-mail respondents supported the state's review of existing Hetch Hetchy Valley restoration studies. Others expressed direct support for the restoration of Hetch Hetchy Valley.

One respondent wanted to know if the SFPUC and the Bay Area Council had provided any substantiation for their claim that Hetch Hetchy Valley restoration could cost \$10 billion, as some press reports had stated.

The California Farm Water Coalition was concerned that tearing down Hetch Hetchy has the potential to place added pressure on California's already overburdened farm water resources. They suggested considering the needs of all Californians and their continued access to a safe, healthy, and affordable food supply.

The Yosemite-Mono Lake Paiute Indian Community asked to be involved in the decision-making process and claimed to be the only direct descendants of the group of Paiutes who owned Hetch Hetchy Valley. They cautioned that members of a tribal consortium present at the workshop are not direct descendants of those who lived in Hetch Hetchy Valley.

Table J-1. Breakdown of comments received

Commenting Entity	Number of Comment Letters Submitted
Bay Area Water Supply and Conservation Agency (BAWSCA)	2
BAWSCA Member Agencies Alameda County Water District (ACWD) City of Brisbane City of Burlingame City of Daly City City of Foster City City of Hayward City of Menlo Park City of Milpitas City of Mountain View City of Palo Alto City of San Bruno City of San Jose City of Sunnyvale Los Trancos County Water District Mid-Peninsula Water District North Cost County Water District Purissima Hills Water District Skyline County Water District Westborough Water District	19
San Francisco Public Utilities Commission	1
Environmental Defense	2
Turlock Irrigation District	1
Comments Received at the Workshop Bob Hackamack, Restore Hetch Hetchy (2) MR (3) Craig Reynold Mark Cederborg George A. Miller Leonie & Richard Smith Russ Brown, Jones & Stokes (2)	11
Comments Received via E-mail R. Morales, Yosemite-Mono Lake Paiute Indian Community David Andrews, Yosemite-Mono Lake Paiute Indian Community Laura Wilson, Santa Barbara, CA Subhash Chand Kris Sullivan, Sonora, CA S. Salas Ray and Richard Smith Farm Mike Wade, Executive Director, California Farm Water Coalition Marty Maskall, Fair Oaks, CA Janet Rich & DeAnne Hart, Watsonville, CA	11
Total	47